THE JOURNAL OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

· MAY · 1915 ·

SPRING MEETING, BUFFALO, JUNE 22-25

CONSCIENTIOUS COMMITTEE WORK

STRICTNESS in conducting inquiry into the qualifications of applicants for membership in national engineering societies possibly deters many from applying, but obviously, it is for the good of the profession that the work of the Membership Committee be conscientiously performed. This work can be greatly assisted by members advising prospective applicants to make their statements quite complete, and invariably to refer to men personally acquainted with their work.

An entirely separate group of members known as the Committee on Increase of Membership, has worked energetically for the past three years to make our members realize how desirable it is to increase the scope of the Society's activities by inviting leading men in all branches of engineering to apply for membership. Many prominent engineers doing splendid engineering work are not members of any society, and it is natural that, if the advantages of membership were sometimes brought to their attention, they should want to become associated with an organization which promotes the work of the engineering profession.

The high standard of membership is thoroughly safeguarded by securing new members in this manner, and members are asked to show their appreciation and offer encouragement by their active coöperation.

Applications filed in May, or up to June 21st, will be acted upon so membership will date from October 1st, the beginning of the next fiscal year.

Total Membership of the Society, April 21, 1915 6241
New Members since January 1, 1915 132

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THE SPRING MEETING

THE SPRING MEETING, to be held at Buffalo June 22 to 25, is the first general meeting of the Society to occur in this city, although there has been one meeting at Niagara Falls. While Buffalo is a beautiful city, always attractive to visitors and of particular interest to engineers because of its diversified manufacturing, part of one day will be spent at Niagara Falls so that all may have an opportunity to enjoy as well the many attractions of this point of national interest. The month of June is the finest time of the year in which to visit this section of the country and the outdoor surroundings of Buffalo and the beautiful Federal Reservation at Niagara Falls will be at their best.

The arrangements for the entertainment of the Society are in the hands of a large local committee of which David Bell is Chairman, James W. Gibney, Vice-Chairman, C. A. Booth, Secretary, and C. H. Bierbaum, Treasurer. The Engineering Society of Buffalo is to join with our own members and with engineers generally in the city as hosts of the occasion.

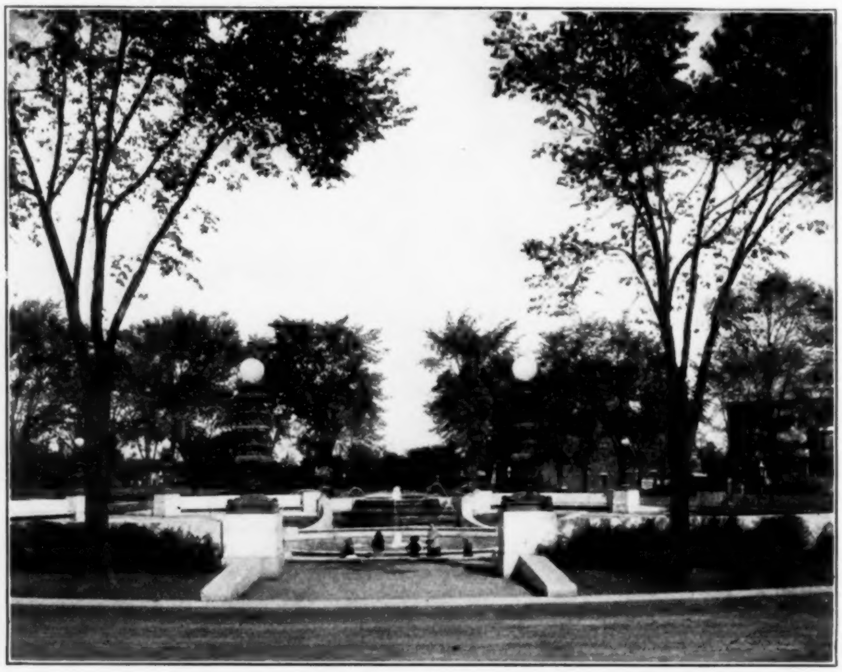
The headquarters during the meeting will be at the Hotel Statler, where most of the sessions and entertainment features will be held. As usual, registration will begin on Tuesday (June 22) and on Tuesday evening there will be an informal reception with an address of welcome by Mayor Louis Fuhrmann of Buffalo. A welcome will also be extended on behalf of the manufacturing interests of the city. Dr. John A. Brashear, President of the Society, will respond, after which the evening will be spent informally and a buffet luncheon will be served.

On Wednesday morning, bright and early, the party is to be conducted to Niagara Falls in time to hold the opening session there, including the business meeting, for which purpose the large auditorium of the Shredded Wheat Biscuit Company has been offered. It is customary at Spring Meetings for local engineers to provide papers for one session, and these papers for the Buffalo meeting will be read at the Wednesday morning session. During the session the ladies of the party will have an opportunity to inspect the Shredded Wheat factory and the plant of the Falls Chocolate Company, both of exceptional interest.

The afternoon will be available for the enjoyment of the beauties and grandeur of Niagara Falls or for visiting any of the industries that have grouped themselves in this city of 50,000 population. Unfortunately, a large number of these plants consider their operations in the nature of secret processes and visitors, especially technical visitors, are not granted admittance. However, some of the factories and the various power stations will be open for inspection. There will be time for those who desire to do so to take the trip of the Gorge Route.

The return to Buffalo will be in time for the lecture on Wednesday evening to be given by Dr. F. H. Newell, formerly Chief of the U. S. Reclamation Service, who has recently spoken so acceptably at several meetings of engineers in different cities and before student sections of the Society. The address will be on The Engineer as a Citizen and will be a presentation of the duties and standing of the engineer in his relation to the public. It will be illustrated by a remarkably fine collection of colored lantern slides illustrating the important work which the government has done in reclaiming the great areas of arid land in the West.

On Thursday morning there will be two simultaneous sessions for the discussion of papers, and the afternoon will be free for visiting the manufacturing plants in Buffalo. On this afternoon, special entertainment is to be provided for the ladies in the way of an automobile ride, with tea served either at the Country Club or the Automobile Club. During the ride there will be opportunity for visiting points of interest, such as the Roycroft Shops at East Aurora, where the Roycrofters engage in the arts of bookmaking, printing, the making of craftsman furniture and various ornamental products. Ladies desiring to visit the Larkin factory also may do so.



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GATES CIRCLE, BUFFALO

On Thursday evening, the usual dance and reception, which is one of the features of the Spring Meeting and always a delightful occasion, will be held at the Hotel Statler.

On Friday morning the final professional session of the meeting will be held, and the afternoon again will be left free for inspection trips.

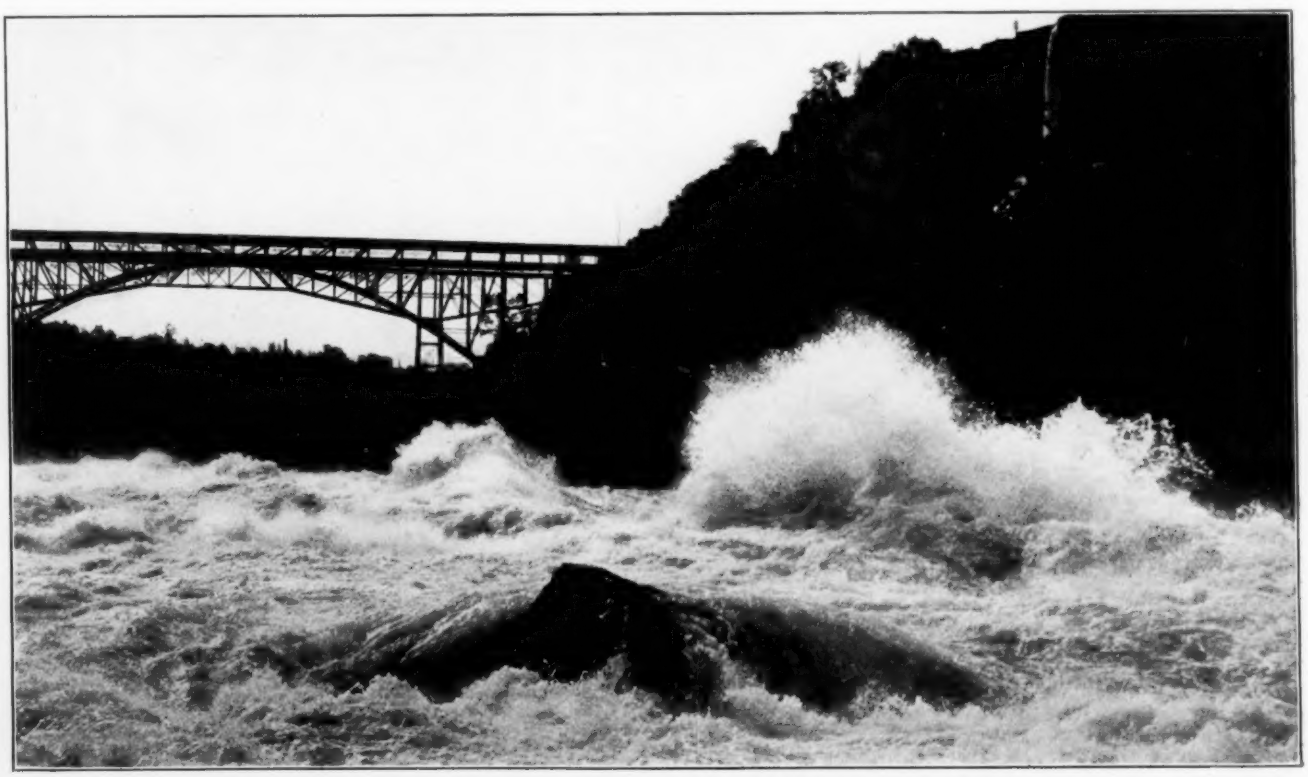
A list of the papers which have already been selected by the Committee on Meetings for presentation at the Spring Meeting with a summary of their contents is given elsewhere in this number. These papers are of a high order of merit and are miscellaneous in character, treating of a variety of subjects. They will be printed in pamphlet form well in advance and will be distributed at the meeting as usual. Any members who desire copies in advance may obtain them upon *application to the Secretary.*

A brief summary of the industries of Buffalo and vicinity and of features of interest both at Buffalo and Niagara Falls are given below, and members and their friends will be cordially welcomed at any of these places.

BUFFALO AND NIAGARA FALLS AND THEIR INDUSTRIES

THE ENGINEERING SOCIETY OF BUFFALO

Of first interest to visiting engineers will be the Engineering Society of Buffalo which, with local members of The American Society of Mechanical Engineers, has extended



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THE WHIRLPOOL RAPIDS, NIAGARA FALLS

MEMBERS AND GUESTS ARE INVITED TO SPEND WEDNESDAY OF THE SPRING MEETING AT NIAGARA FALLS

Plant of Lackawanna Steel Company, Buffalo

the cordial invitation to visit Buffalo. The Buffalo Society was formed only three years ago but already has 320 members, of which 50 are members of the Am. Soc. M. E. While an independent body, it feels that it owes a large measure of loyalty to the national Society and does all in its power to encourage the local members to join. It is broadly representative of all engineering activities, including in its membership civil, electrical, and mining engineers, chemists and architects. Meetings are held every two weeks.

BUFFALO FOUNDRY AND MACHINE COMPANY

This plant has a capacity in its cupolas for melting 55 tons per hour and many castings up to and over 100 tons weight are made, and besides there is ample equipment for machining large pieces. One of the specialties is the production of vacuum apparatus for all purposes, including small laboratory experimental devices and machines with a volumetric capacity as great as 5 ft. in diameter by 12 ft. long. Over 60 years ago David Bell, Sr., evolved his first designs of steam hammers which have since been another specialty of this company and are built in sizes up to 200 tons in weight.

THE LACKAWANNA STEEL COMPANY

This is generally considered to be the largest independent steel producing plant in the world. It covers approximately 1500 acres along the shore of Lake Erie, near Buffalo, and gives employment to about 12,000 men. The annual payroll expenditure is over $10,500,000 and the gross production about 1,250,000 tons.

Of interest to the members of the Society will be the Lackawanna deseaming process for rails which formed the subject of a paper at the last annual meeting by Robert W. Hunt of Chicago, Ill. Visitors should also see the new W-9 Merchant Mill which is the latest word in planning and construction. This design has been the result of extensive study of other mills at home and abroad. One interesting feature that always strikes the visitor is the "Safety Arch." It will be noticed in the photograph on page IX that there are tags extending on each side of the frame. These bear the names of the different departments and when all is well, a small metal American flag flies alongside each, but if an accident has happened during the preceding 24 hours, the flag is covered with a black sleeve. Great interest is taken by the men in keeping their flags flying and this arch has been of decided value in reducing the number of accidents.

LARKIN COMPANY

In 1878, the Larkin Company conceived the idea of selling directly from factory to ultimate consumer. The idea prospered and from a small beginning in a factory having an area of 3000 sq. ft. their business has grown until today it is housed in a plant containing some 40 acres of floor space. This immense factory is devoted to the production

Shelton Square, Buffalo

of soaps, perfumes, kitchen necessities and the staple groceries such as tea, coffee, sugar and spices.

The office building where the large and extremely complicated affairs of the Company are conducted typifies the last word in office system. Particular attention has been paid to lighting by direct daylight during the day and by indirect illumination during the evening. Phonograph dictation is used. Desks and chairs are all designed so that they take up the least possible floor space and allow for maximum cleanliness. Chairs swing under the desks when not in use, thus leaving the aisles practically clear. Much of the furniture is of pressed steel in a special design.

This careful attention to detail is followed throughout the factory. One of the most interesting things to visitors is the system whereby Larkin products are distributed to all parts of the country. The shop floors are divided into sections, each named for a State in the Union. Box cars are taken on large elevators and lifted up to the floor which is named for the State that is their ultimate destination. Here the car is completely loaded, thus avoiding excessive handling and damage by trans-shipment.

THE WICKWIRE STEEL COMPANY

The Wickwire Steel Company operates a small but very high quality blast furnace plant within a very short distance of Buffalo. Their plant is very modern, having been erected in 1910. The output is in the neighborhood of 350,000 tons of iron a year. The company owns its ore properties, and also a fleet of large lake carriers for transporting the ore to the plant. They make a special point of producing special analyses of iron, and their methods of handling raw material to insure that the analysis shall be as specified will prove of much interest to visitors.

PRATT AND LAMBERT COMPANY

The Pratt and Lambert Company is one of the world's largest varnish manufacturers, and their plant in Buffalo offers much that is of interest. Their "Vitralite" white enamel, which can be brushed within a short time after its application, is of particular interest to engineers, and the company extends a cordial welcome to visitors. This company is one of the largest national advertisers, and maintains a complete printing equipment capable of handling not only the ordinary run of work but elaborate color printing as well.

SNOW STEAM PUMP WORKS

This is one of the plants of the International Steam Pump Company, and was originally established in 1889. Since then it has enlarged to many times its original capacity. The Indianapolis pumping station built in 1895 was equipped with what was, at that time, the largest pumping engine in the world, built by this company. In 1900 this concern took up the manufacture of gas engines, concentrating attention on the largest sizes only. The total horsepower of the gas engines built by them up to 1914 was 211,000.

Prior to the expiration of the Diesel patents, this company had been investigating oil engines and in 1912 they began to produce two- and four-cycle Diesel oil engines, both of the horizontal and vertical type. These are also made chiefly in the largest sizes and their design represents the latest developments of this work in the United States.

A visit to the Snow Steam Pump Works should certainly be taken by those interested and a cordial invitation is extended.

PIERCE-ARROW MOTOR CAR COMPANY

The Society is invited to make the works of this company one of the points of interest to be visited. This is considered to be one of the most up-to-date factories of the type in the country and its product is confined strictly to high grade automobiles and motor trucks. It has an area over 1,000,000 sq. ft. The ideals of the company are high and engineers will be impressed with the methods used to insure that the materials employed are up to specifications. Forgings and castings, although coming in in large quantities, are all carefully inspected and tested with the scleroscope or Brownell machine to ascertain that the heat treatments have been properly carried out. In addition, a laboratory and metallurgical department are maintained for research into the latest developments and uses of materials. The company does not do its own forging or foundry work, but has large machine shops, firing rooms and assembling departments.

The product consists of pleasure cars in three models, 38, 48 and 66 h.p. and also two capacities of motor trucks, 2-ton and 5-ton, equipped with special devices for handling all kinds of loads. These trucks will be of especial interest to engineering contractors, by whom they are largely used.

The Pierce-Arrow Company is also noted for its welfare work, and those interested in this line of endeavor should not miss the opportunity of seeing their large kitchen and dining hall and other conveniences that have been provided for the use of the employees. Altogether some 4000 men are employed.

SOME BUFFALO FOUNDRIES

To those interested in foundry work, the plant of the Pratt and Letchworth Company will well repay a visit. This is an exceedingly large foundry, specializing in freight car and locomotive castings in malleable iron and steel. The plant, although an old one, is constantly being brought up to date.

Other foundries are the Bingham and Taylor Company, also a large company, which is just now developing a process for making small steel castings.

The Aluminum Castings Company has a large plant devoted to the production of very large but thin aluminum castings.

The D. W. Sowers Manufacturing Company specialize in the casting of small, high grade cylinders for gas and oil engines. Their product is being used by the Curtis Aeroplane Company.

THE BUFFALO FORGE COMPANY

This is one of Buffalo's largest industries. The company specializes in the manufacture of ventilating and drying apparatus under the Carrier patents. Mr. W. H. Carrier, member Am. Soc. M. E., has installed his humidifiers in many varied industries and it is stated that his system has greatly facilitated the manufacture of cotton and woolen goods in this country.

THE SIMONDS MANUFACTURING COMPANY

Lockport is a small city some 25 miles from Buffalo and

is easily reached by trolley car. The Simonds Manufacturing Company located there, manufactures saws, files and steels and have a large plant which is well worth a visit.

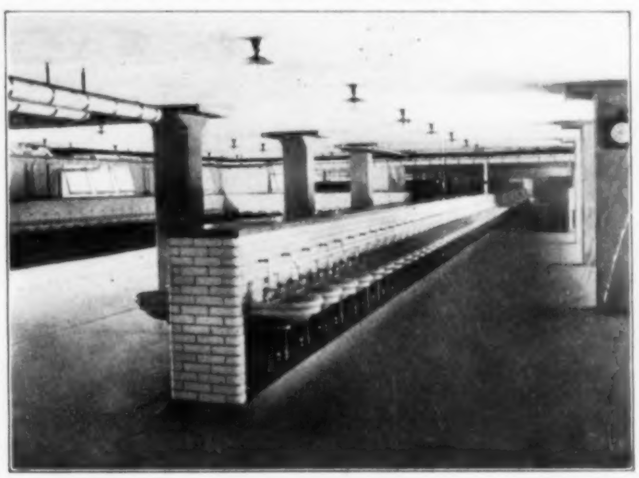
Erecting Shop—Snow Steam Pump Works

Plate Mill—Lackawanna Steel Company

Safety Arch—Lackawanna Steel Company

View of Plant—Pierce Arrow Motor Car Company

Dining Hall—Pierce Arrow Motor Car Company



Model Lavatory—Pierce Arrow Motor Car Company

MEMBERS ARE CORDIALLY INVITED TO VISIT THE INDUSTRIAL PLANTS OF BUFFALO

The location is near enough to the Falls to make electric power easily available, and this company is now installing a large electric furnace for the production of a very high grade of tool steel. There are many special features in connection with this, such as the use of fluid compression in the manufacture of high grade armor plate in conjunction, of course, with the Simonds Company's well known quality of tools, and a visit to the plant will be of interest.

While in Lockport the visitor should not miss the opportunity of inspecting the immense locks on the barge canal which connects Lake Erie with the Hudson River.

THE ROYCROFT SHOPS

Another place in the vicinity of interest especially to the visiting ladies, is East Aurora, a beautiful country town only 18 miles from Buffalo, the home of Elbert Hubbard and the Roycroft Shops. The Roycrofters form a community operating their own hotel, or rather inn, and their own farm. Mr. Hubbard has advanced ideas on the responsibility of the employer towards his work and workmen which he attempts to carry out in all sincerity. This institution is unique in the United States and never fails to interest visitors and to provide them with considerable food for thought.

IN GENERAL

There are so many varied industries in Buffalo that it is impossible to mention all of them, but visitors have only to make known the factories they wish to visit and the committee of the Buffalo Engineering Society, which is looking after this matter, will do their best to enable them to visit the plants in which they are specially interested.

NIAGARA FALLS

Of first interest from an engineering standpoint at Niagara Falls are the power plants and here are located also the many electro-chemical industries, which, however, in general, are not open to the public. One-half million electric horse power are being generated and supplied at low cost to districts as far as 250 miles distant. This is the home of the Shredded Wheat Biscuit Company, famous throughout the country because of its model factory, a favorite place for visitors and a meeting place for societies holding conventions at Niagara Falls. The plant of the Falls Chocolate Company is also of interest.

At this time of the year the natural attractions of Niagara Falls, the Park and Goat Island constituting the Government Reservation, the beautiful foliage, the wooded slopes extending down to the rapidly rushing waters in the Gorge will be at their best. The Gorge trip, extending on both sides of the Gorge and on the American side, practically at the water's edge, is always an attraction of interest.

ABSTRACTS OF PAPERS TO BE PRESENTED AT THE SPRING MEETING

LAPS AND LAPPING

BY W. A. KNIGHT AND A. A. CASE

This paper gives details of tests of abrasives when used for lapping operations with the object of determining the effect on the rate of cutting with different combinations of abrasive, lubricant, and lap material. The tests were made with hardened steel specimens, on a machine built especially for the purpose.

Comparative results were obtained with emery, alundum, and carborundum used in connection with lard oil, machine oil, gasoline, kerosene, turpentine, alcohol, and soda water. The lap materials were cast iron, soft steel, and copper.

The investigation shows that in general there is a lubricant that will give best results with a given combination of abrasive and lap. Thus, emery on the cast lap gives best results with gasoline and kerosene, while lard oil and machine oil are distinctly inferior. On the other hand, with carborundum on the steel and copper laps, lard oil and machine oil do the best work of any of the lubricants tested, while gasoline and kerosene do the least efficient work with these combinations. Lard oil invariably gives a higher rate of cutting than machine oil.

Carborundum usually gives a higher rate of cutting than the other abrasives, but it also wears the lap faster. The tests show that carborundum wears the lap surface about twice as fast in proportion to the amount ground from the steel specimen as does emery, and the wear with alundum is one and one-fourth times that with emery. Also, the wear of the copper lap is about three times, and the steel one and one-fourth times, that of the cast iron. This wear is shown to be inversely proportional to the hardness of the lapping plates, as shown by the Brinell test.

Comparisons were made, too, between the "wet" and the "dry" methods of lapping. In dry lapping much depends on the manner of charging the lap. Results show that with the wet method the rate of cutting is two to six times as fast as with the dry, depending on how the lap was charged.

MODEL EXPERIMENTS AND THE FORMS OF EMPIRICAL EQUATIONS

BY E. BUCKINGHAM

The object of this paper is to illustrate the use of the dimensional method of reasoning in devising empirical equations and in planning and interpreting experiments,—particularly experiments on models.

After stating the principle of the method in the form of a convenient theorem application is made to the familiar problem of flow through smooth pipes so as to illustrate the working of theorem in a well known case. The next application is to the resistance of totally immersed bodies such as submarines: it leads to the notion of dynamical similarity and the interpretation of experiments on models. Application to the air resistance of projectiles shows how compressibility of the resisting medium is to be allowed for when the speed is high. Application to the screw propeller illustrates the treatment of a slightly less elementary problem, involving more variables, and shows how approximations, which are often unavoidable, may be introduced. The last problem treated is introduced for the sake of showing that the dimensional method is not restricted to the field of mechanics. It deals with an elementary case at heat transmission, and in the course of it some new points are brought out with regard to the practical working of the details of the dimensional method.

These illustrations—which might be multiplied almost indefinitely—have been selected with a view to elucidating some of the various devices which are of use in the practical application of new problems.

The method of reasoning is purely algebraic and therefore, in itself, rigorous. But while it cannot supply any new facts, because it is only mathematical and not physical, it often illuminates facts already known in a quite surprising manner, and sometimes permits our analysing and coördinating experimental data which without this guide seem hopelessly confused or contradictory.

RATIONAL DESIGN AND ANALYSIS OF HEAT TRANSFER APPARATUS

By E. E. Wilson

The results of tests of heat transfer apparatus have been so inconsistent that the formulation of rational bases for design is precluded. This lack of agreement leads to the conclusion that some variable has been neglected, and a study of the results of tests on feed-water heaters and condensers leads to the belief that this variable is the viscosity of the circulating water. Since the accepted law for heat transfer is of the same general form as that for the resistance to flow in pipes, it seems likely that there is some close relation. It also seems probable that the effect of viscosity is of the same general character in each case, and on this assumption the published results for heat transfer are corrected in the same manner as are the results of Osborne Reynold's work on the resistance in pipes to flow of water through them. With this correction the results are reconciled, not only in an individual case, but for different experimentors as well.

If now these results as corrected, are put in the form of resistances to heat transfer, a linear relation is found to exist between the resistance and the reciprocal of the water velocity. The correction for viscosity may be put in this same form as a function of temperature. The resistance may then be evaluated in terms of its component parts and reduced to the form of an equivalent film of water of known thickness. These linear expressions may now be incorporated in a form giving the area of the heating surface required to transmit a given quantity of heat under the given flow conditions, in a condenser or feed-water heater. This expression seems rational in form and applicable throughout the range of practice, and in addition it seems possible through the use of the relations established to determine by experiment a similar expression for the resistance to heat transfer in other types of apparatus.

PAPERS FOR THE SPRING MEETING

BRIEF abstracts of the papers for the Spring Meeting, which have been assigned by the Committee on Meetings up to the time of going to press, are here published for the convenience of those who desire to secure advance copies. Announcement of additional papers will be made in the next number of The Journal. All of the papers for the Spring Meeting will be printed in pamphlet form in advance for distribution, and copies of any or all of them will be sent to members prior to the meeting upon application to the Secretary. After the meeting extended abstracts of the papers and an account of the proceedings, with discussion, will appear in The Journal, so that members will have early information concerning the events of the meeting, together with material that was presented. Finally, the papers, together with the discussion, will be printed in complete form in the annual volume of Transactions for 1915 for permanent reference

INFLUENCE OF DISK FRICTION ON TURBINE PUMP DESIGN

By F. zur Nedden

The mathematical survey of the problem leads to these conditions for a minimum loss through disk friction:

a Smoothness (polish) of both disk and casing. Roughness of either is equally detrimental.

b Smallest possible surface of both. Excessive extension of surface is equally detrimental whether it is the surface of the disk or of the casing.

c Outward indication of attainment of minimum is the fact that waste-water rotates half as fast as impeller.

A gyrostatic pressure is generated by the rotation of the waste-water and added to static pressure prevailing at periphery of impeller.

From the influence of the width of the impeller it follows that it is important to keep the thickness of metal at the periphery as small as possible. Protruding rims are objectionable.

The influence of the ordinary roughness of non-machined castings has no perceptible effect on the efficiency except with high lift pumps. Painting or japanning the surfaces generally seems less desirable than machining them with a medium heavy cut. High polish seems wasted. The experiments verify conclusion of mathematical survey.

The influence of viscosity is proportional to its fifth root; yet, it is responsible for an improvement in the efficiency of hot-water turbine pumps. The effect of pumping heavy oil and tarry liquid is estimated. The influence of fluid density is almost exactly proportional to the specific gravity.

The loss through disk friction constitutes a constant percentage of the useful power at all speeds in one and the same pump. Generally its percentic value grows with the value of $\frac{\text{Head per stage}}{\text{Capacity}}$ at constant speed, and diminishes with increasing speed and constant ratio $\frac{\text{Head per stage.}}{\text{Capacity}}$ High heads are more economically produced by high speeds or a greater number of stages than by increasing the diameter of the impellers, but the number of stages should be left to the discretion of the makers, not fixed by specifications. A steep angle between impeller blades and the tangent at the periphery serves very considerably to improve the efficiency owing to indirect reduction in disk friction losses, especially in high lift pumps.

The disk friction reaches a minimum for a certain width of the waste water chamber which is about ⅝ in. for disks of 12 in. diameter. The increase with increasing width is due:

a To the increase in retarding surface

b To the induction of secondary or induced hydraulic currents.

Concentric ribs are advantageous, radial ribs are detrimental.

In single-stage pumps the rotation of the waste water reduces the tendency for leakage by about 20 to 35 per cent. In multistage pumps the same influence may even increase the leakage.

Inequality in shape or roughness of the waste-water chambers on both sides of the impellers produce a gyrostatic axial thrust due to disk friction which can assume very considerable values. The direction of this thrust is indicated by the rule. The impeller is drawn to the side where the waste-water rotates farthest.

A STUDY OF AN AXLE SHAFT FOR A MOTOR TRUCK

By John Younger

The shaft in question is the driving shaft on a large motor truck which transmitted 16½ h.p. at 27 rev. per min., and gave trouble by breaking after some service. The conditions of the shaft were investigated very closely and the methods by which, first of all the design was improved, are given in detail. It was found, however, that this was not sufficient and the only problem left was as to whether the material could not be improved. It was impossible to increase the size of shaft without running into various difficulties and experiments were made to improve the strength of material. It was finally found that by suitable heat treatment the elastic limit of the shaft could be raised to 175,000 lb. per sq. in. Experience with these heat-treated shafts has now extended over a period of two years, during which the results have been perfectly satisfactory.

CORRUGATED FURNACES FOR VERTICAL FIRE TUBE BOILERS

By F. W. Dean

This paper discusses the advantages of using corrugated furnaces for vertical boilers, and gives as advantages the absence of staybolts and a slight amount of elasticity. It also speaks of the different sizes that can be obtained and the horse power of boilers that can be realized from furnaces of the largest size now made, and states some points to be borne in mind when making a design of such furnaces. It also speaks of their behavior under hydrostatic test, and of the proper method of flanging the fire door opening. The paper gives illustrations of two boilers with such furnaces that are now in use.

THE EFFECT OF RELATIVE HUMIDITY ON AN OAK TANNED LEATHER BELT

By William W. Bird and Francis W. Roys

A careful study of the effect of changes in the relative humidity on a 4-in. single oak tanned leather belt was made and the results analyzed.

The effect most closely connected with the use of leather belting for power transmission was found to be in the lengthening of the belt with an increase in the relative humidity. This change in the length of the belt reduces the belt tension provided the distance between the pulley centers remains constant. This effect varies with the relative humidity, but is greater at high temperatures and less at low temperatures, but not in direct proportion to the absolute humidity.

The conclusions are that the relative humidity should be considered when a belt is tightened, the initial tension being made less for high relative humidities and greater for low; that a spring or gravity tightener should be used if it is desired to eliminate the effect of changes in humidity.

Leather is more or less of an uncertain material, the treatment and quality varies and hence these conclusions should be considered only in a general way.

THE RELATION BETWEEN PRODUCTION AND COSTS

By H. L. Gantt

In the past it has been pretty common practice to make the product of a factory at a portion of its capacity bear the whole expense of the factory. This has been long recognized by many to be illogical, but so far there has not been presented a rational theory as to what proportion of the expense such a product should bear.

Mr. Gantt offers the theory that the amount of expense to be borne by the product, should bear the same ratio to the total normal operating expense, as the product in question bears to the normal product, and that the expense of maintaining the idle portion of the plant ready to run is a business expense not chargeable to the product made.

This latter expense is really a deduction from profits, and shows that we may have a serious loss on account of having too much plant, as well as on account of not operating our plant economically.

DESIGN OF RECTANGULAR CONCRETE BEAMS

By Howard Harding

The resisting moment of a reinforced concrete beam may be represented by the formula $M = Rbd^2$ where b is the breadth, d is the depth and R is a numerical co-efficient depending upon $E_s \div E_c$ f_s f_c and the percentage of steel reinforcement.

The paper outlines the development of two graphical diagrams, for the direct solution of the above equation. By their use the usual "cut and try" operations are eliminated. The diagrams are of the logarithmic form and since all the lines are straight and either horizontal, vertical, or at about forty-five degrees, the mechanical work of determining intersections is greatly facilitated.

By use of the first diagram the dimensions of beams just strong enough to withstand safely any desired bending moment are determined.

The second diagram gives factors by which the dimensions obtained from the first diagram are multiplied in order to correct for the bending moment due to the dead weight of the beam itself.

The beam should be checked for shearing stresses, and shear reinforcement added where necessary.

At the end of the paper a typical example is worked out in detail and a suggested form of computation is given.

SOME MECHANICAL FEATURES OF THE HYDRATION OF PORTLAND CEMENT AND THE MAKING OF CONCRETE AS REVEALED BY MICROSCOPIC STUDY

By Nathan C. Johnson

Little has been actually known of the basic relations between the various materials entering into the composition of concretes. With a view to determining these, methods similar to those employed in the microscopic study of the structure of steels have been applied to a study of concretes.

As a result, new knowledge has been obtained with re-

gard to the functions of the various dissimilar ingredients of the concrete and as to the detrimental effects of foreign impurities, such as entrained air; and explanation is offered as to why, even with the best of materials, only low-strength structural material is obtained.

The production of binding substance, through the hydration of cement is also investigated by the microscope and a surprisingly low efficiency of use is found to obtain in all concretes. This relates further to the permanency of under-water concretes and reasons for failures are demonstrated and explained.

SURFACE CONDENSERS

By Carl F. Braun

This paper presents the matter of the surface condensation of steam in connection with the most recent developments in condenser design and construction. The application of the logarithmic mean temperature difference between the steam and cooling water is taken up with reference to the counter current and parallel current system of circulation and a number of curves developed for the determination of the mean temperature difference.

The conditions affecting the variation of heat transfer through condenser tubes are carefully analyzed and presented in an original manner.

The main feature of the paper is its presentation of the principles of condenser design which are held to be correct theoretically and mechanically and the application of the principles involved to recent developments in the construction of condensers. The matter of steam circulation throughout the condenser is thoroughly discussed and the great importance of this point dwelt upon. The paper in the whole though presenting nothing startlingly new, discusses an old subject in a new and original way and points out the laws along which the modern surface condenser is developed.

COUNCIL NOTES

At the meeting of the Council on April 9, 1915, the President announced the following appointments: Tellers of Election, H. A. Hey, Chairman, H. P. Hayes and R. H. Kirk; Committee on Classification of Engineering Literature, F. R. Low, Chairman, L. P. Breckenridge, W. W. Bird, A. E. Forstall and E. J. Prindle; this committee to coöperate with the Committee of the American Gas Institute, and also to report on a similar matter from a recent meeting of members in New York and referred by the Council to this committee.

Coöperation has been requested by this Society in the movement to form a reserve corps of civilian engineers representing all branches of the engineering profession. The Council recorded its sympathy with the proposed movement and voted that the President appoint a committee of five to coöperate with the War Department and committees of the other societies, who have taken similar action.

The Committee on Public Relations, and the Society's representatives on the Conference Committee of the National Engineering Societies, are authorized to be present at the State Constitutional Convention, and to coöperate with the other engineering societies at conferences.

A communication was received from the American Association for the Advancement of Science asking that this Society assist in formulating plans to improve the present method of securing expert testimony.

Voted: That the Society coöperate with other technical societies in any movement having for its object better practice in the use of the expert testimony of engineers in court proceedings, and that a special committee of five be appointed by the Chair, to carry on such coöperative work, such a committee to include in its membership one member experienced in the use of expert testimony in patent causes, one in the use of expert testimony of engineers in accident cases, and one in the use of experts in valuation cases.

The names of A. R. Baylis, A. M. Houser, Julian Kennedy and W. M. White were announced as the additional members of the Committee on Hydraulic Flanges of which the Council had named H. G. Stott as Chairman.

Voted: To approve and appoint as a local committee on meetings of the Society in Worcester, Mass., the following, duly nominated at a regularly called meeting of members in Worcester and vicinity: P. B. Morgan, Chairman; E. H. Reed, Secretary; C. F. Dietz, F. W. Parks and H. P. Fairfield.

Prof. Frederick R. Hutton reported that the Committee on the Sir William H. White Memorial had forwarded a draft for 60 pounds, to the Committee in England in charge of this memorial.

Voted: That a committee of five be appointed by the Chair to formulate general principles for the guidance of those who may serve the Society in a respresentative capacity and particularly when dealing with public questions.

APPLICATIONS FOR MEMBERSHIP

Members are requested to scrutinize with the utmost care the following list of candidates who have filed applications for membership in the Society. These are sub-divided according to the grades for which their age would qualify them and not with regard to professional qualifications, i.e., the age of those under the first heading would place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, while those in the third class are qualified for Junior grade only. The Membership Committee, and in turn the Council, urge the members to assume their share of the responsibility of receiving these candidates into the Membership by advising the Secretary promptly of any one whose eligibility for membership is in any way questioned. All correspondence in regard to such matters is strictly confidential and is solely for the good of the Society, which it is the duty of every member to promote.

These candidates will be balloted upon by the Council unless objection is received before June 10, 1915.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Ambler, Nathan B., Supt., The Toronto Pwr. Co., Ltd., Niagara Falls, Canada

Bettis, William I., Designing Engr., Layne & Bowler Corp., Los Angeles, Cal.

Bohn, Gebhard C., Vice-Pres., White Enamel Refrigerator Co., St. Paul, Minn.

Boyd, H. L., Ch. Safety Engr., Dept. of Safety, State of Cal., Los Angeles, Cal.

Chambers, Albert N., Walker & Chambers, Engrs. and Contractors, New York

Coppage, Benjamin D., Ch. Engr., The Pusey & Jones Co., Wilmington, Del.

Dickinson, Arthur R., Te tile Rep., Lockwood, Greene & Co., Atlanta, Ga.

Flagg, Charles N., Jr., Secy., The Taylor-Flagg Co., Meriden, Conn.

Griswold, Howard L., Mech. Engr., Central Cal. Traction Co., Stockton, Cal.

Hawes, Alex. G., Asst. Supt. Central Deleias, Cuban Amer. Sugar Co., Cuba.

Hayward, Judson, Secy. and Genl. Mgr., The Hayward Co., New York.

Hoffenreffer, Rudolf F., Pres., Fall River Water Board, and Treas. and Genl. Mgr., Old Colony Brewing Co., Fall River, Mass.

Hope, Walter R., Ch. Draftsman, E. I. du Pont de Nemours Powder Co., Wilmington, Del.

Kasley, John H., Engr. of Layouts, Western Elec. Co., Hawthorne, Ill.

Lanigan, James A., Fdy. Supt., Frontier Iron Wks., Buffalo, N. Y.

McCracken, William C., Ch. Engr. and Supt. of Bldgs. and Grounds, The Ohio State Univ., Columbus, Ohio.

Morse, Robert W., Asst. Examiner U. S. Patent Office and Asst. Prof. of Mech. Engrg., The George Washington Univ., Washington, D. C.

O'Brien, John E., Asst. Mech. Supt., Missouri Pacific Rwy. Co., St. Louis, Mo.

Stephenson, Thomas U., Pres. and Mgr., Knoxville Iron Co., and The Cross Mountain Coal Co., Knoxville, Tenn.

Stoddard, Clifford J., Ch. Insptr., Employers Liability Assurance Corp., Boston, Mass.

Tollerton, William J., Genl. Mech. Supt., Chicago, Rock Island & Pacific Ry., Chicago, Ill.

Walser, Arthur, Dist. Mgr. Motor Dept., General Electric Co., Denver, Colo.

Wheatley, Arthur W., Vice-Pres. and Genl. Mgr., Canadian Locomotive Co., Kingston, Ont., Canada.

White, Alfred D., Service Engr., Green Engineering Co., East Chicago, Ind.

Zanke, George J., Dist. Sales Mgr., American Engrg. Co., Chicago, Ill.

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Ballou, F. H., Traveling Engr., Great Western Sugar Co., Denver, Colo.

Bryen, Thomas T., Mech. Engr., Mesta Machine Co., Pittsburgh, Pa.

Carlson, Carl T., Ch. Engr., Springfield Boiler & Mfg. Co., Springfield, Ill.

Carver, Edgar M., Res. Rep., Dodge Sales & Engrg. Co., and Dodge Mfg. Co., Indianapolis, Ind.

Hubbard, Frank B., Asst. Plant Engr., Pierce Arrow Motor Car Co., Buffalo, N. Y.

Huntar, Felix, Asst. Engr. Mchy. Dept., American Can Co., New York

Kemp, Francis I., with Henry R. Worthington, St. Louis, Mo.

Kent, Herbert S., Draftsman, with Charles B. Rearick, New York

Kulling, Otto W., Asst. Engr., with Albert C. Wood, Cons. Engr., Philadelphia, Pa.

Meserole, Kenneth A., Engrg. Dept., American Beet Sugar Co., Oxnard, Cal.

Ross, Alastair, Ch. Engr., Central Soledad Sugar Factory, Guantanamo Sugar Co., Guantanamo, Cuba.

Smith, Harold A., Foreman Mech. Dept., Amoskeag Mfg. Co., Manchester, N. H.

Trenfield, Ernest J., Asst. Mech. Engr., Orconera Iron Ore Co., Ltd., Luchana, Bilbao, Spain.

Walker, William C., Tech. Asst., Semet Solvay Co., Syracuse, N. Y.

Watson, Jay E., Draftsman, The George W. Blabon Linoleum Co., Nicetown, Philadelphia, Pa.

Williams, William W., Genl. Draftsman, Brooklyn, N. Y.

FOR CONSIDERATION AS JUNIOR

Allentuch, James, Instr., Genl. Elec. Engrg. School, Lynn, Mass.

Bernard, Harold B., with The Industrial Instrument Co., Foxboro, Mass.

Githens, Thomas F., Asst. Engr., American Sugar Refining Co., Brooklyn, N. Y.

Hill, Dudley M., with Industrial Inst. Co., Foxboro, Mass.

Junkins, John N., Engr., Aberthaw Constr. Co., Boston, Mass.

Lincoln, Howard A., Mech. Engr., Strathmore Paper Co., Woronoco, Mass.

McCart, Raymond D., Student, Massachusetts Inst. of Tech., Boston, Mass.

Mahoney, John F., Draftsman, Fire Dept., New York.

Maurer, Rolland E., Cadet Engr., Utah Gas & Coke Co., Salt Lake City, Utah.

Trego, A. C., Indus. Engr., Workmen's Compensation Service Bureau, New York.

Wigren, Clarence F., 641 49th Street, Brooklyn, N. Y.

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM JUNIOR

Wilcox, Carl C., Asst. to Cons. Elec. Engr., Hodenpyl, Hardy & Co., Jackson, Mich.

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GAS PRODUCERS WITH BY-PRODUCT RECOVERY

BY ARTHUR H. LYMN,[1] LONDON, ENGLAND

Non-Member

THE art of generating producer gas from coal is a very old one, but the development of the simultaneous recovery of the valuable by-products is comparatively recent, having been confined to the last twenty-five years or so. The object of this paper is to present a historical resumé of this development in Europe, and also to outline some of the latest features of the Lymn system of by-product recovery for which the author has been responsible.

The early attempts in Europe to recover the by-products of the producer gas process are generally recognized to have been made in Great Britain. In that country the knowledge that the treatment of fuel by a mixture of steam and air (the former in excess) would convert a large percentage of the nitrogen contained in the coal into ammonia was first applied in practice on a large scale. The details of a plant to operate on this principle had always been worked out by Messrs. Young and Beilby in England and Grouven in Germany among other investigators.

The gas producer designed by Young and Beilby differed in operation from the ordinary by-product gas producer in that it was heated from the outside. The coal was distilled in the upper part of the producer or retort and the tar vapors passed down through red hot coke and were (it was claimed) decomposed into permanent gas and ammonia. The coke in the lower half of the producer was burned in a mixture of steam and air and the resulting gases, together with the gaseous products of the coal distillation, passed out of the producer by way of exits at the middle. The arrangement is shown in Fig. 1.

It is particularly interesting to note that, as far back as 1883, Young and Beilby claimed to recover in the form of ammonia from 60 to 70 per cent of the total nitrogen in the fuel and that the percentage composition of their gas was:

Carbonic acid	16.6 per cent
Carbonic oxide	8.1 per cent
Methane	2.3 per cent
Hydrogen	28.6 per cent
Nitrogen	44.4 per cent

Although their retort was heated from the outside instead of the air and steam blast being superheated, it will be seen that the results claimed by them as to ammonia were not far short of what we realize to-day. The gas composition, too, was practically the same as that of the gas which has since become so widely known as Mond gas and which has the following percentage composition:

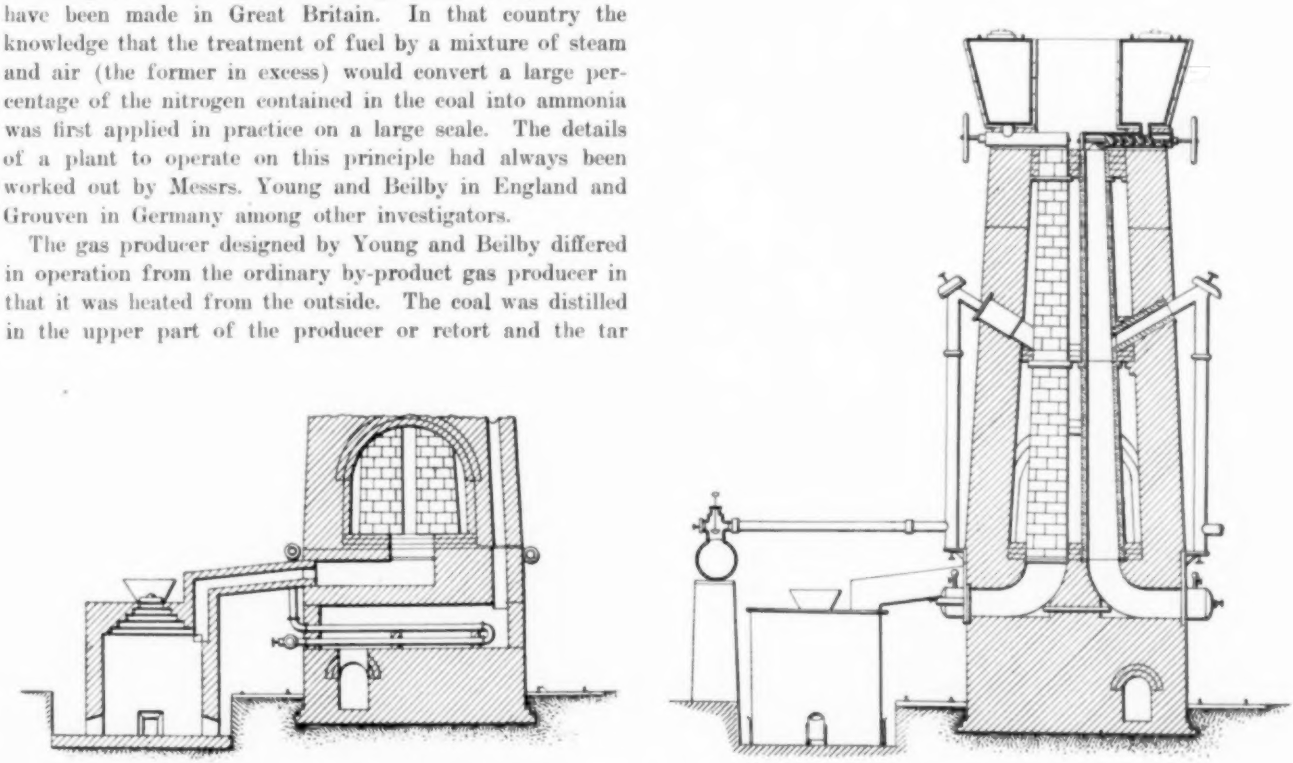

FIG. 1 YOUNG AND BEILBY'S BY-PRODUCT GAS PRODUCER

Carbonic acid	14 to 16 per cent
Carbonic oxide	10 to 12 per cent
Methane	2 to 3 per cent
Hydrogen	25 to 29 per cent
Nitrogen	Difference

The above makes it obvious that Dr. Mond was not the first investigator to produce gas of this composition.

It is now rather more than twenty-five years since the late Dr. Ludwig Mond first put into commercial practice the process described in his British Patents No. 3821 of 1883 and 8973 of 1885, of gasifying fuel by means of steam and air and simultaneously recovering the ammonia. His first plant was installed at the works of Brunner, Mond and

[1] Sanctuary House, Tothill Street, Westminster, S. W., London, England.

Presented at the New York local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on November 10, 1914.

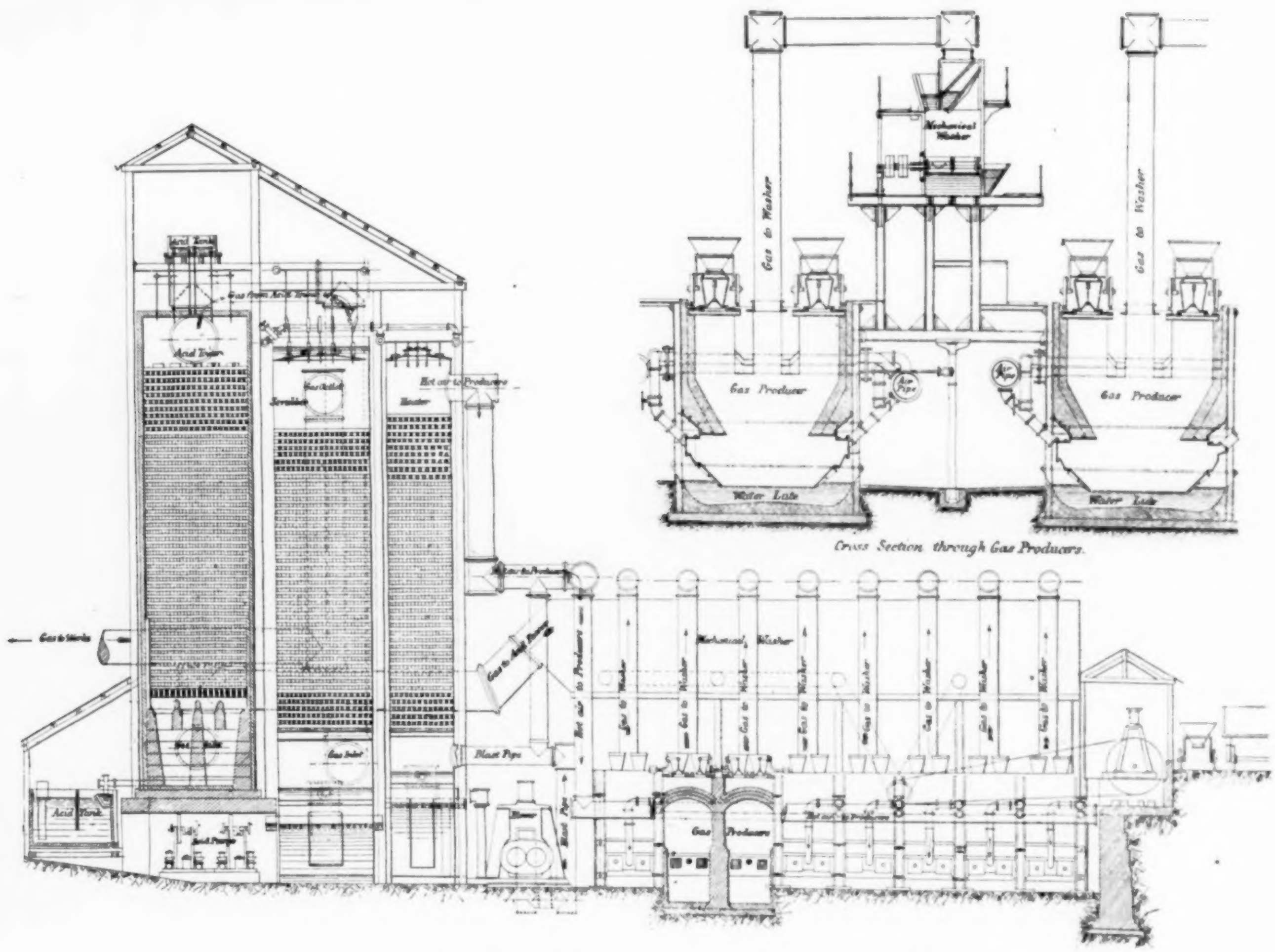

FIG. 2 MOND SYSTEM PRODUCER GAS AMMONIA RECOVERY PLANT

Co., Northwich, England, and its capacity was developed to some 200 tons a day. Unfortunately this plant was not in a good position to be photographed, but a diagram of it is given in Fig. 2.

The Mond producer was rectangular in section and was formed with a kind of double chamber. Its operation was similar to that of Young and Beilby, in that the coal was distilled in a downward direction in the upper part and the coke residue was gasified in the lower part, all the gases mixing and leaving the producer together. The gas was passed into a long horizontal rectangular washer and a fine spray of water was thrown into it by a series of revolving dashers. By this means a large proportion of the dust was removed, which was afterwards taken out of the water lute manually with long scoops, an irksome operation. From the washer, the gas was conducted into a high lead-lined acid tower (filled with earthenware ring tiles) where in passing upwards it came into contact with sulphate of ammonia solution trickling down. This solution contained a slight excess of sulphuric acid and deprived the gas, by absorption, of nearly all the ammonia contained in it. From this tower, the gas was passed into a similar tower, called the scrubber, where it was brought into contact with cool water for scrubbing and cooling it and it was then delivered for use.

The water, having taken up the heat of the gas, was collected in tanks from which it was introduced into the heater,

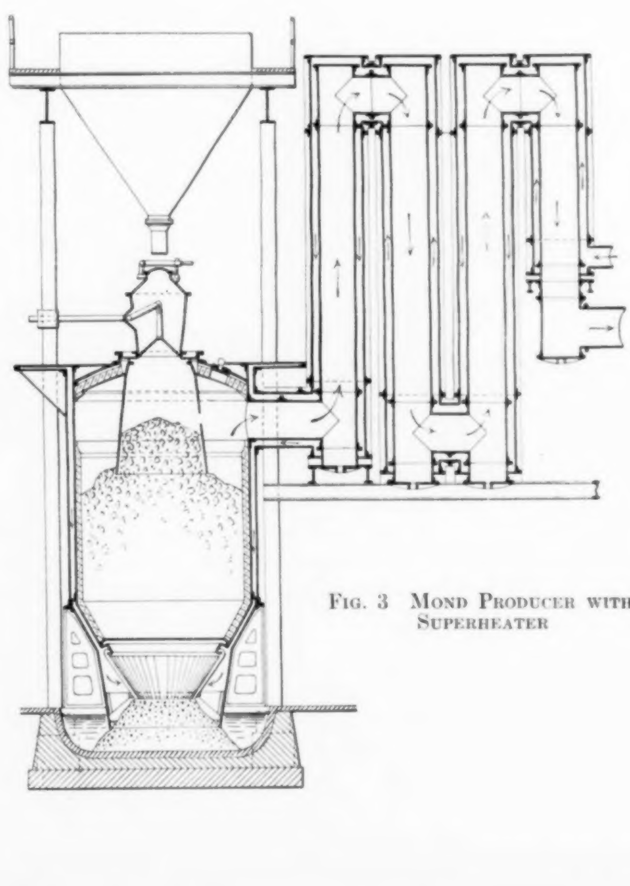

FIG. 3 MOND PRODUCER WITH SUPERHEATER

also of tower construction. It was here brought into contact with the cold air to be used in the producers, saturating this air with water vapor at from 70 to 80 deg. cent. and becoming again cooled. Then it was returned to the scrubber, where it again took up the heat of the gas, and so on in a continuous cycle.

After this plant had been in operation for some time, it was found that, owing to the large proportion of steam in the air blast, the heat value of the gas was below the desired standard and also the yield of ammonia was less than that which Dr. Mond had set out to obtain. It was therefore decided to change the design of the gas generating part of the plant so that the air and steam blast would enter the producer with a considerable degree of superheat, thus enabling a still greater excess of steam to be used. This modified design was disclosed in Mond's British Patent No. 12,440 of 1893 and is shown in Fig. 3. The producer was made circular in section instead of rectangular and its whole shell was surrounded by a jacket through which the air was passed on its way to the grate, reducing the losses from radiation and at the same time further superheating the steam and air blast. Directly contiguous to the producer was arranged a superheater, consisting of a series of parallel tubes with alternate ends connected, surrounded by a series of larger tubes forming an annular space. The gas from the producer passed through the inner tubes and superheated the steam and air blast which was passed through the annular space in a counter-current direction on its way to the producer. With this provision, the gas was found to possess a much higher heat value and a considerably increased yield of ammonia was obtained without extra fuel.

It is interesting to note that Dr. Mond, with that great courage in engineering undertakings for which he was famed in

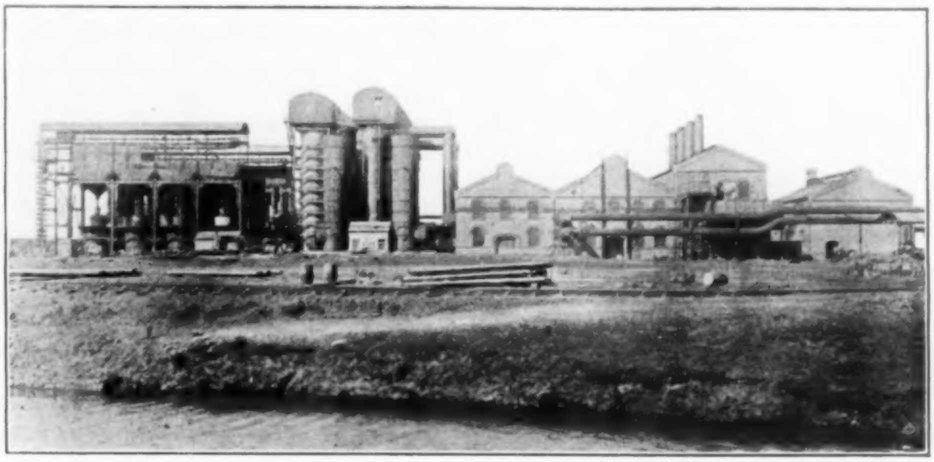

Fig. 4 Mond Gas Central Station at Dudley Port, England

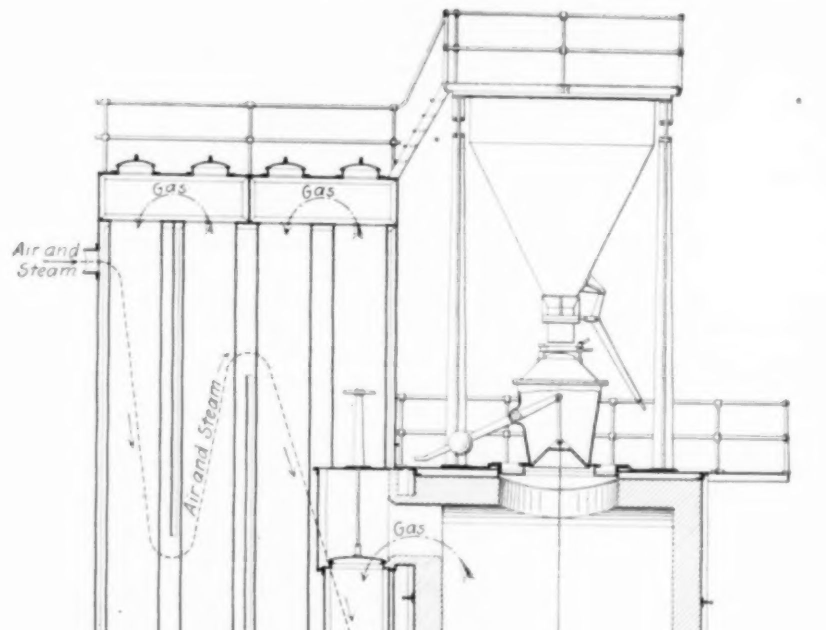

Fig. 5 Duff Producer with Superheater

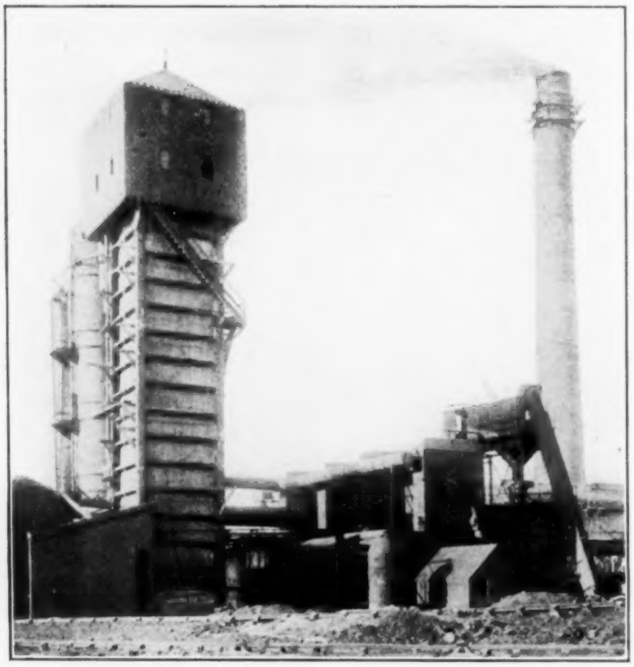

Fig. 6 Duff Plant at Fleetwood, England

the days of his greatest activities, built a very large unit plant at the outset, and smaller plants in later years. This was contrary to the usual order of things, and discloses the reason for the widespread idea that by-product producer plants were only profitable when built in very large and costly units.

Among the plants built by Dr. Mond or his successors in England—The Power-Gas Corporation—the central station at Dudley Port, Staffordshire, for the distribution of Mond gas over an area of about 120 square miles, through about 30 to 40 miles of pipes, is of particular interest. The author had charge of this plant for some time. The gas from this station is supplied to iron and steel works, machine shops, foundries, galvanizing works, pumping stations, enameling works and municipal electric stations. The installation had originally a capacity of 16,000 h.p., which has just recently been largely increased. A general view of this plant which is familiar to many engineers in this country is shown in Fig. 4.

The Dudley Port plant is quite unique in that it is the only central station in the world designed and built for the distribution of producer gas. The gas is sold to consumers in competiion with coal, ordinary lighting gas and electricity. The advantages to be derived from taking supplies of the gas were not apparent to the public for several years, but once they had been fully demonstrated the number of consumers rapidly increased.

Up to about the year 1897, Dr. Mond was constantly endeavoring to improve his process, but after that time he appeared to be satisfied with his design and in fact in advancing years he became adverse to any material modifications. The result was that the design of the Mond plants did not advance with the times and the writer is of the opinion that in those cases in America in which Mond system plants have not been so successful as was expected, it has been chiefly attributable to this factor and to the failure to realize that a certain state of reliability and efficiency in other countries, with quite different fuels and under totally unlike conditions, is not necessarily a criterion for exactly the same results in this country.

After Dr. Mond had demonstrated the success of his process, it was not long before another worker, E. J. Duff, claimed attention. As a whole Duff's plant embodied very little to distinguish it from the Mond plant, the same process being of course carried out in the two plants. Duff's producer was of rectangular section inside, with rounded corners, and his superheater, as shown in Fig. 5, consisted of a series of parallel gas tubes with alternate ends connected, surrounded by one chamber. Baffles plates in this chamber compelled the steam and air blast to take a zig-zag path on its way to the producer. Except for this slight difference in the construction of the superheater, which, however, occasioned no difference in the action of the producer, there was practically nothing to distinguish the Duff plant from the Mond plant.

Several large plants were constructed according to Mr. Duff's designs. One of these is shown in Fig. 6. This was erected at Fleetwood, England. The photograph does not show the producers very well but conveys a good idea of the great height and size of the towers for ammonia absorption, gas cooling and air saturation. These large towers are characteristic of the plants of this construction. It is well known in Great Britain that Mond and Duff were

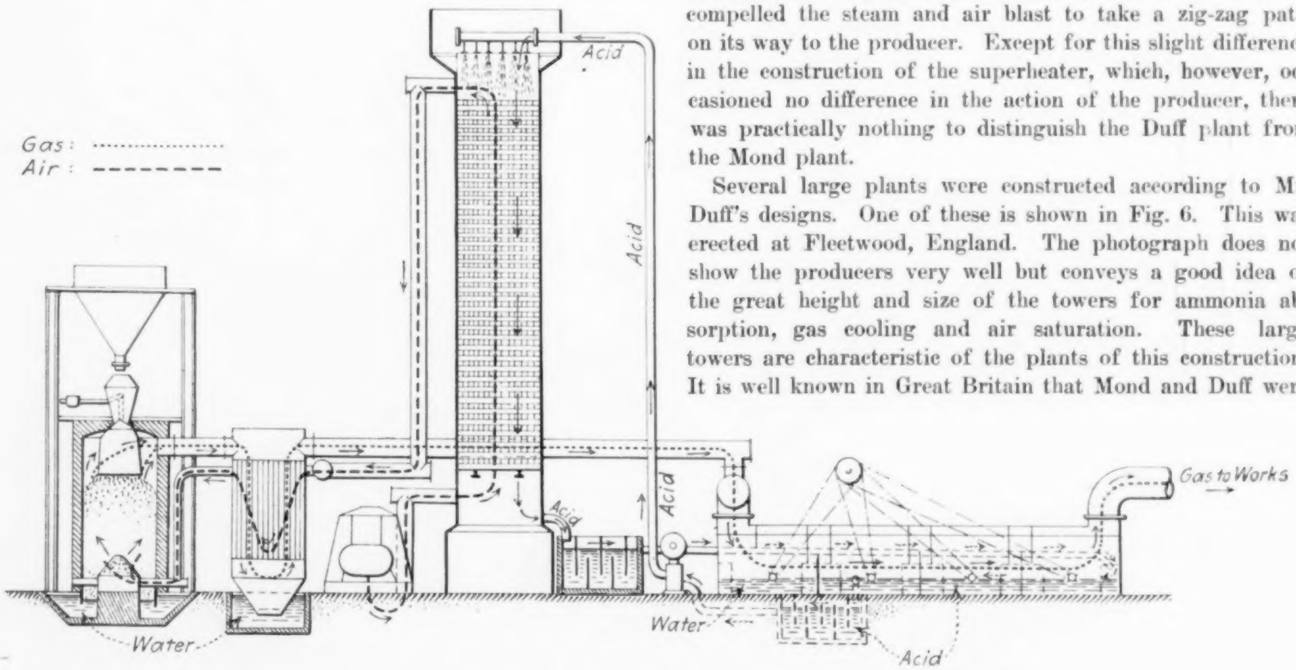

Fig. 7 Crossley and Rigby Patent Ammonia Recovery Plant

at one time in conflict in the matter of their patents, but that their interests were afterwards amalgamated into one company, The Power-Gas Corporation, formed in 1901. The patents in question have since expired in England, but it may be that some of Duff's American patents are still in force.

Messrs. Crossley Bros., of Manchester, were the next to claim material improvements, which, however, do not appear to have been realized in practice. In fact, it is the author's belief that some time ago this firm ceased altogether to build plants for the gasification of coal and the simultaneous recovery of the by-products. It is perhaps nevertheless of interest to include here a diagram of the first form of plant Messrs. Crossley Bros. adopted (Fig. 7).

Briefly the claims made for this plant were that the washing and cooling of the gases, as well as the condensing of the water vapor and the absorption of the ammonia, took place in one and the same apparatus, the ammonium sulphate liquor being utilized for the purpose of saturating the air with water vapor and the liquid being thereby cooled at the same time. As a matter of fact, in the first series of operations a washer made up of two compartments was used, and the gas would leave this apparatus in a more or less uncooled state and also practically saturated with water vapor at a compartively high temperature. Fig. 7 does not therefore show all the necessary apparatus.

The second claim made, that is, that the air was saturated by means of the sulphate liquor, represented a very dangerous practice. A fine sulphate of ammonia liquor spray, with its excess of highly-corrosive acid, would naturally be carried forward to the superheaters, etc., and with very obvious results. Messrs. Crossley Bros., as a matter of fact, took out later a patent for the utilization of the above system in combination with a somewhat costly bed of lime, which the saturated air had to pass through, clearly to absorb its contained acid spray.

The next step in the development of this process the author feels justified in claiming to have taken himself

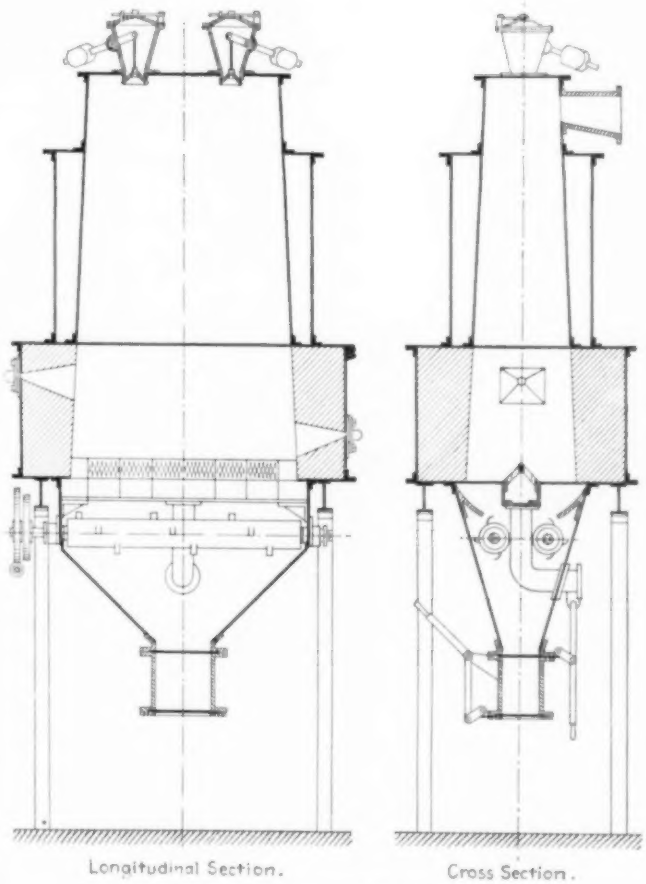

FIG. 9 MOORE'S THREE-PART PRODUCER

on the basis of his British Patent No. 8014 of 1908. This was an attempt to entirely dispense with the costly and irksome towers of the Mond and other plants, which became blocked up from time to time causing serious trouble and delay. The attempt was made by replacing the mechanical

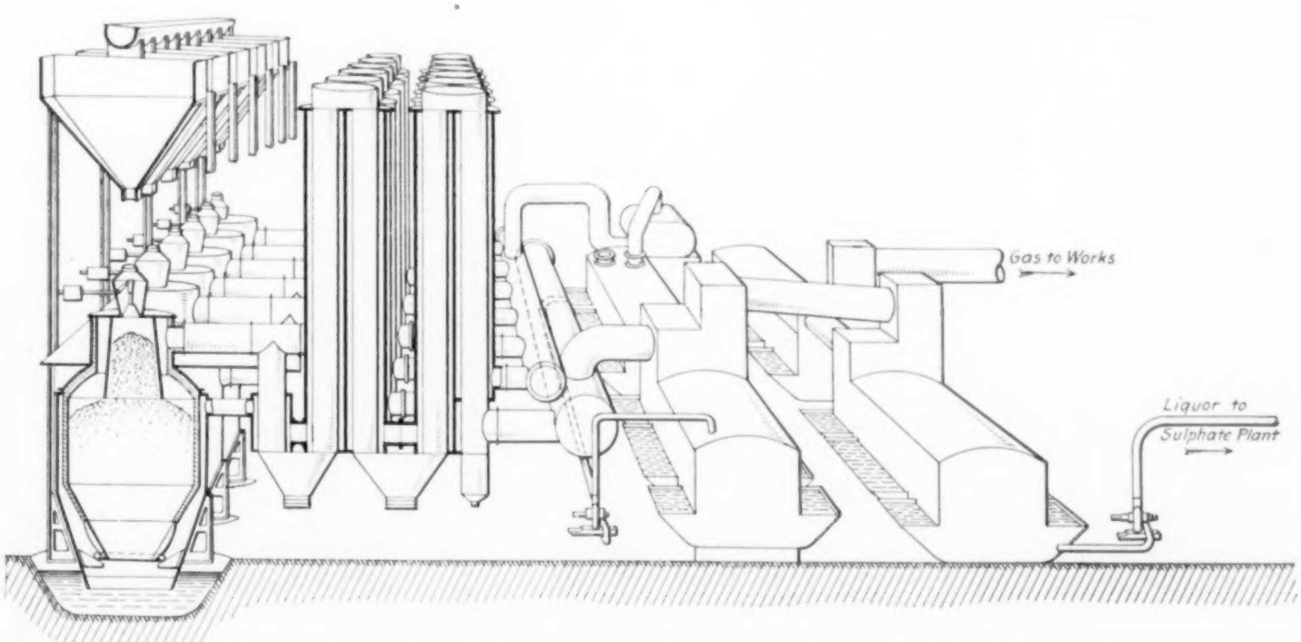

FIG. 8 MOND TYPE AMMONIA RECOVERY PLANT WITH DOUBLE CHAMBER WASHERS

washer and towers by washers of special construction, which obviously could not become blocked up. Four double washers were proposed, one for washing the gas, the second for absorbing the ammonia, the third for cooling the gas and the fourth for saturating the air. This design was later modified in favor of a double-luted washer and was changed a third time by The Power-Gas Corporation for a combination of double and single chamber washers upon the same principle. An idea of the general appearance of a plant with these washers may be obtained from Fig. 8.

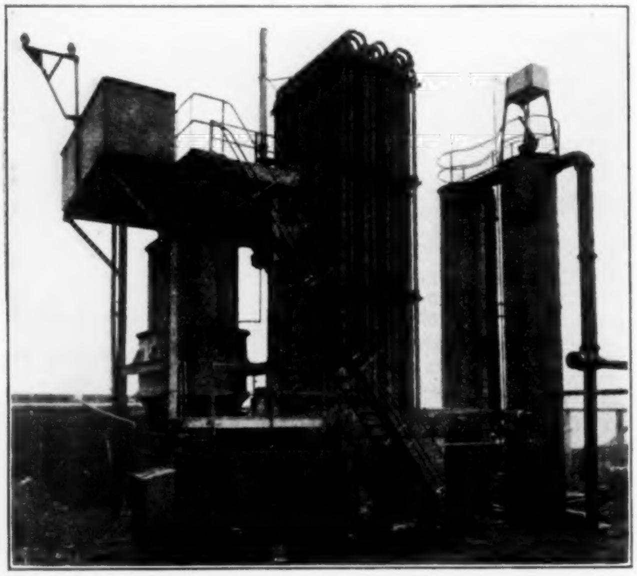

FIG. 10 MOORE'S PATENT SYSTEM BY-PRODUCT RECOVERY PLANT

Various modifications of ammonia recovery plants are also disclosed in patents taken out by A. B. Duff, of Pittsburgh. Notable among these is a producer with a circular grate and also a circular section superheater with four enclosed gas tubes. The former is illustrated in British Patent No. 16,164 of 1903 and the latter in British Patent No. 16,243 of 1903. These modifications have been adopted in Great Britain in two or three plants and are, I believe, working successfully with Scotch and other more or less non-caking coals.

In another design (British Patent No. 4372 of 1910) A. B. Duff claims that by passing the gas around the evaporator before entering the washers, its heat can be utilized for evaporating the sulphate of ammonia liquor. On first sight, this idea appears to be a good one, but it seems to the writer that great difficulty may be experienced in carrying it out in practice on account of the dust and tar present in the gas at this stage of the operations. Moreover, it must be borne in mind that in this design the gas is washed before it is allowed to enter the ammonia absorption tower, and that the washing water is used for saturating the air going into the producers. It therefore appears that the air will carry to the producers a not inconsiderable proportion of the ammonia which will thus be lost. The author is not aware of a plant on these lines having been built and put into operation, and is but meagrely informed concerning the earlier Duff plants built in the United States.

It may be taken that all the designs above referred to were, broadly considered, based upon what is generally known throughout the world as the Mond process. Two different propositions for the gasification of coal and the simultaneous recovery of the by-products will now be referred to.

The first of these is that by F. J. Rowan, of Glasgow, who proposed to combine the gas producer process with the usual process utilized in lighting gas works, viz., to replace the absorption of the ammonia by acid (as is done in the Mond process) by a condensing plant. He did not propose to actually produce the ammonia in any different way, and it is obvious that since, for every ton of coal gasified, approximately 150,000 cu. ft. of gas at normal temperature and pressure, together with about 1.5 tons of excess water vapor, are produced, an apparatus for condensing the ammonia cannot be otherwise than very excessive in size. Moreover, the gases enter the condensing plant at a temperature of 400 deg. cent. or more, at which temperature their volume is multiplied several times. The condensed ammonia liquor is extremely dilute and must be distilled with lime in the usual manner adopted in lighting gas works, a not very pleasant operation. These facts make the difficulty of carrying out this proposition obvious, and the writer is not aware that any plant was built on these lines. The author himself has tried surface cooling for by-product producer gas but has found firstly, that meterological conditions have too much influence on the result and secondly, that the apparatus required would be much more expensive owing to the large volume of gas to be dealt with and the lower rate of heat transference possible.

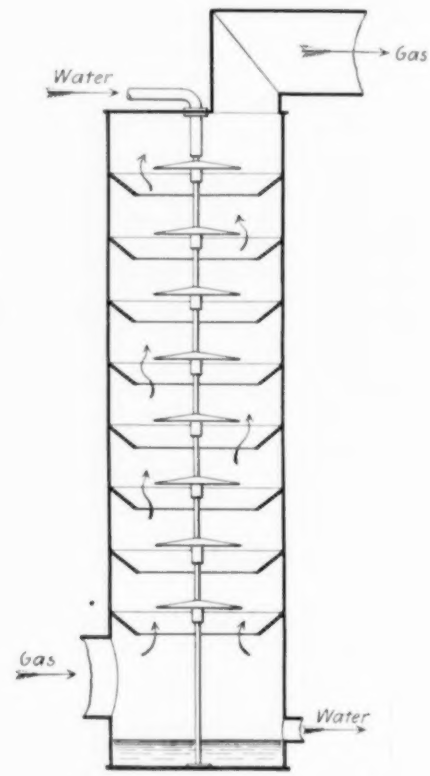

FIG. 11 LYMN TYPE WASHER

The second proposition is that by Quintin Moore who designed a producer divided into three parts, a lower brick-

lined part, a middle water-jacketed part and an upper air-cooled part. The arrangement is shown in Fig. 9.

By this cooling of the upper part of the producer, Moore claimed to obtain a good yield of ammonia with about half the amount of steam in the air blast. It does not seem likely, however, that such cooling can penetrate far into the fuel bed, and it should not be overlooked that other workers, in particular the late Dr. Mond, previously considered the possibility of recovering ammonia by means of merely cooling the producer, but came to the conclusion (based on sound scientific knowledge) that cooling was not the only desideratum in ammonia recovery.

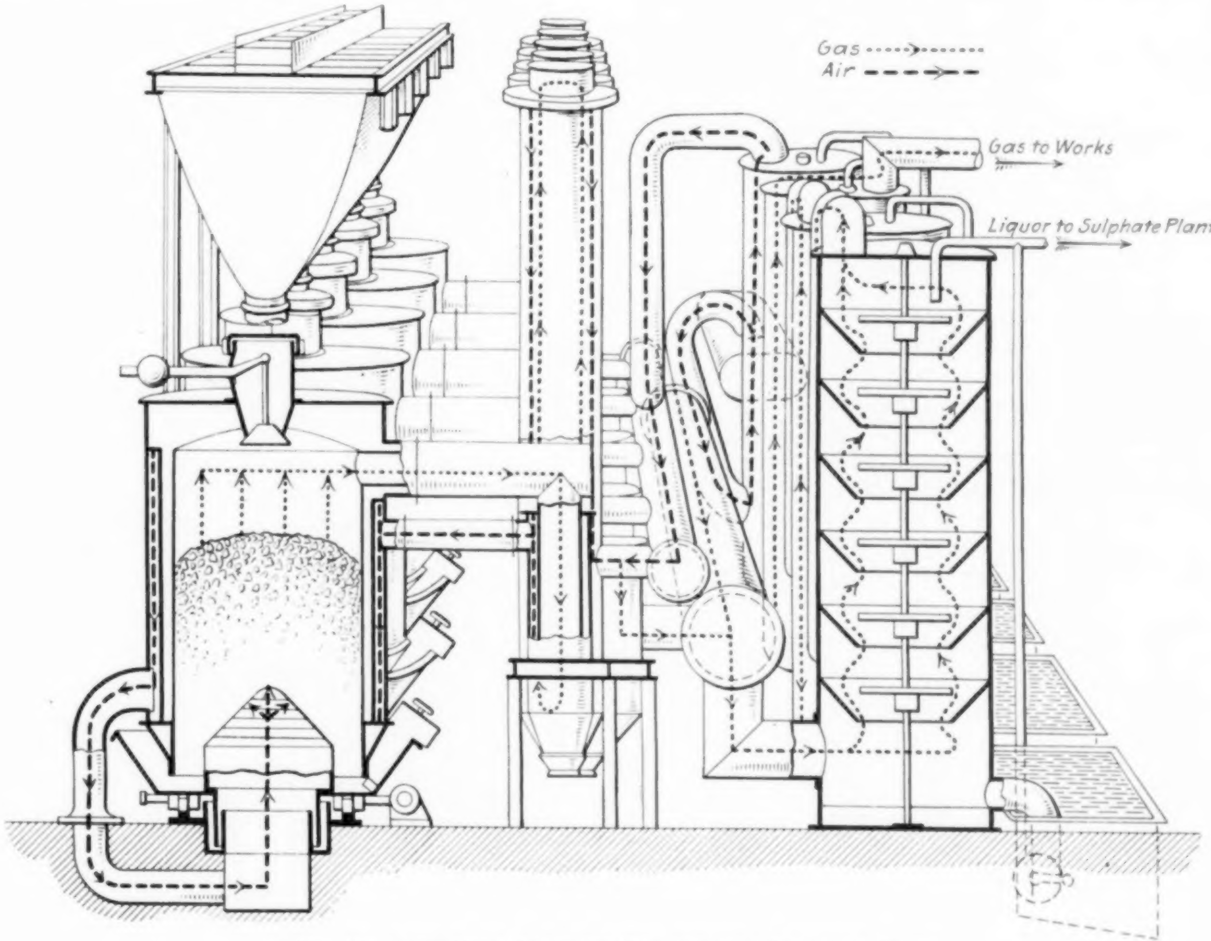

Fig. 12 Lymn Type Producer Gas Ammonia Recovery Plant

One can easily overrate, too, the importance of saving steam. In the Mond process, practically all the steam is generated from waste heat and, moreover, most of it is continuously recovered. Any further saving can only be secured at the expense of some of the sulphate of ammonia yield. At all events, Mr. Moore states in his published matter that he obtains more ammonia when he introduces more steam, hence his usual amount of steam does not produce the maximum ammonia recovery.

Fig. 10 illustrates a plant built on the Moore system. The small air-cooled tubes are so constructed and in such a position as to bring about great likelihood of frequent stoppage of the plant on account of tar and dust deposits. Whatever may be the results with this plant with non-caking coals, the plant does not seem to be applicable to caking fuels with any reasonable degree of efficiency. The only publication regarding this system which has come before the writer shows the results of tests of but five hours duration, which tests have obviously but little value for practical purposes.

Some five years ago the writer set out to design a new type of plant which should retain the advantages of previous types without their disadvantages. He was led to do this by the realization that, in spite of the extreme cheapness of producer gas as made by plants operating under the Mond system and although a considerable number of plants had been built and operated in a somewhat restricted number of countries, the adoption of the producer gas process had not become general throughout the industrial world. Careful investigations of the situation led to the conclusion that although the process as such was, and is, really good, the means adopted for carrying it out left much to be desired, especially from the point of view of capital outlay, labor requirement, repair costs and simplicity of operation.

These drawbacks were inherent primarily to the ammonia absorption, gas washing, gas cooling and air saturating elements of the plant. All these operations were heretofore carried out in high and cumbersome towers packed with earthenware ring tiles, or in equally cumbersome horizontal luted dasher washers, both of which the author set out to replace.

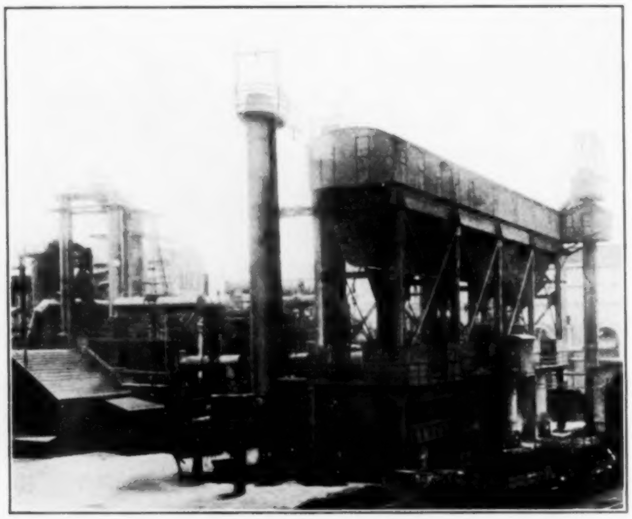

Fig. 13 8000 H.P. Lymn System Producer Gas and By-Product Recovery Plant

A system of vertical washers, in which an intensive washing of the gases was brought about chiefly by means of the momentum of the gases, was first designed and put into practice. Vertical mechanical washers had not previously been used in gas producer plants and the writer first designed one on the lines already known in other branches of the gas industry, in which the washing liquid was sprayed by means of a series of co-axial revolving discs onto collecting cones, each of which delivered the liquid directly onto the next revolving disc below, and so on. It was found, however, in setting this washer to work, that with such an arrangement, the momentum of the gas was performing much more work than was the mechanical movement of the discs, a rather surprising fact. Accordingly, the mechanical feature of the washer was eliminated, the collecting cones were cut away to give the gas more play and the washer now had the appearance as shown in Fig. 11. It will be seen that if plumb lines are taken down the inside edges of the collecting cones and down the outside edges of the discs, a considerable space exists between them, which is such in practice that, if no gas is passing, the water entering at the top falls straight down to the bottom.

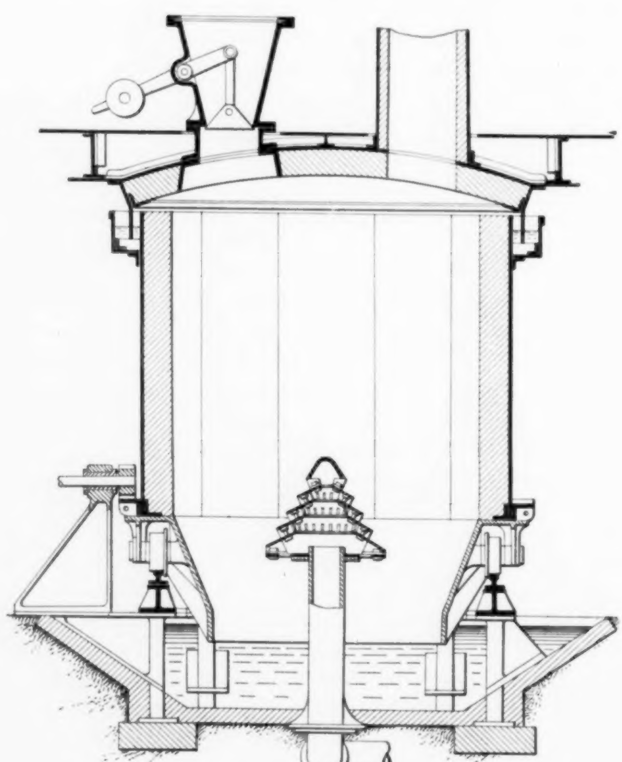

Fig. 14 Duff Patent Revolvable Producer

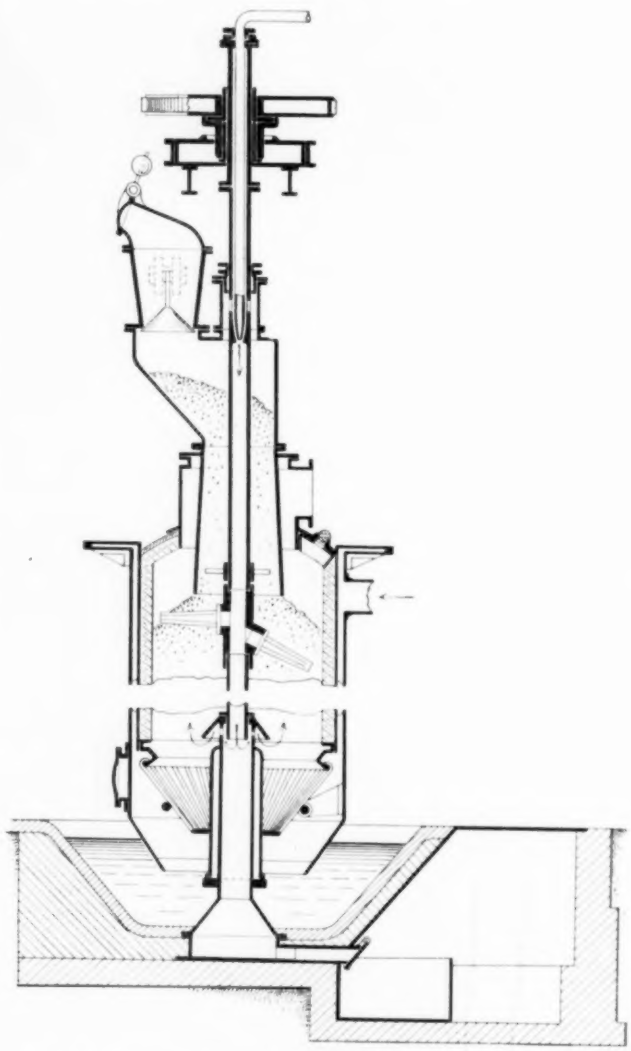

Fig. 15 Mond Producer Combined with Talbot Stirrer

With this modified washer, a plant originally designed to deal with the gas from 45 to 50 tons of coal per day was able to deal with that from 90 to 100 tons per day, so that the capital outlay of the gas washing part of the plant was straightway reduced one half. Such washers have now been in operation for approximately two years with entire success, and it is now possible to design washer units of this particular type to deal with quantities of gas from 10,000 up to about 1,300,000 cu. ft. per hr.

Fig. 12 illustrates the general appearance of a plant with these Lymn washers. The dimensioning of the washers is not a very simple matter, being of necessity purely empirical, and the author has arrived at the dimensions en-

tirely by stepwise trial, which has obviously not been done without considerable expense.

If Fig. 12 is compared with the previously shown diagrams of other plants, it will be seen that the whole apparatus looks much less cumbersome and obviously simpler in operation, involves less auxiliary machinery and consequently less first cost. It will be further noted that in the

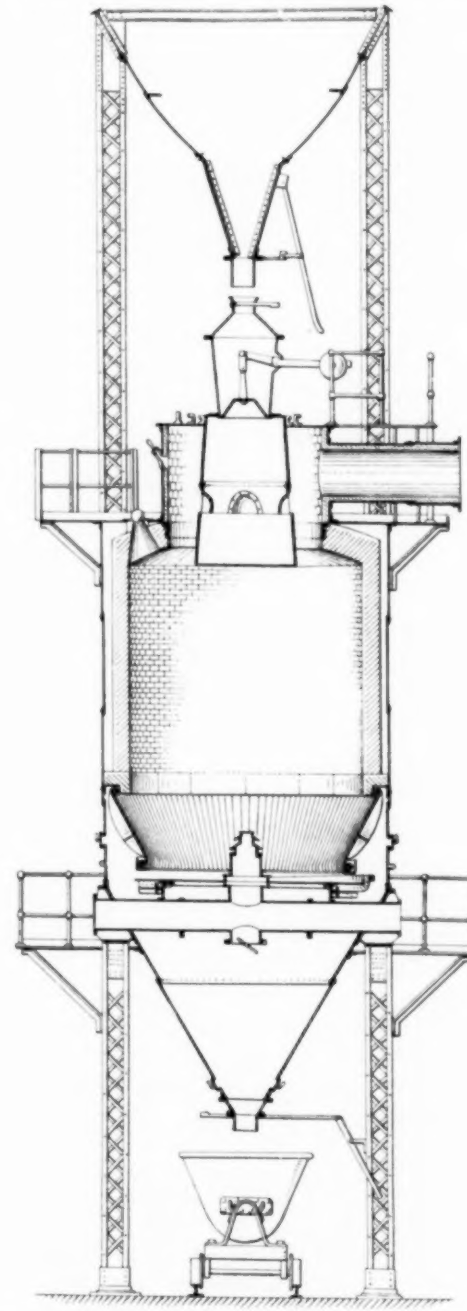

Fig. 16 Mond-Trump Producer with Dry Ash Discharge

Lymn system exactly the same kind of apparatus is employed for each of the operations of absorbing the ammonia, cleaning the gas and recovering the steam. For the final stage of removing the last traces of tar, etc., however, centrifugal cleaners combined with dry scrubbers, or such methods as have been proposed by H. F. Smith, have to be utilized.

One other point to which attention might be drawn is that the Lymn plants do not contain any lead parts, steel being used for the parts of ammonia absorbing apparatus. A Lymn plant constructed with no lead whatever has been in operation in German for approximately four years and no corrosion has yet been discovered. This plant is shown in Fig. 13. Its capacity is 8000 h.p.

A second direction in which the author claims to have made considerable improvements is in the removal of dust. These improvements have been accomplished by the adoption of a cyclonic dust separator of somewhat special design.

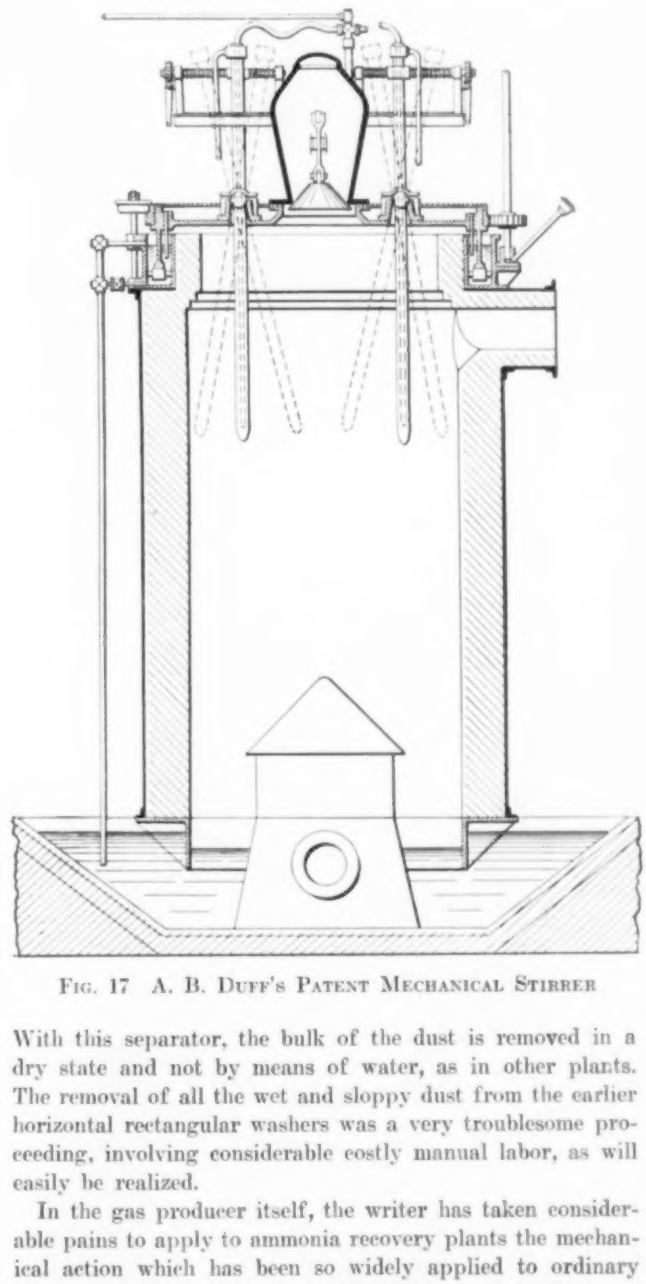

Fig. 17 A. B. Duff's Patent Mechanical Stirrer

With this separator, the bulk of the dust is removed in a dry state and not by means of water, as in other plants. The removal of all the wet and sloppy dust from the earlier horizontal rectangular washers was a very troublesome proceeding, involving considerable costly manual labor, as will easily be realized.

In the gas producer itself, the writer has taken considerable pains to apply to ammonia recovery plants the mechanical action which has been so widely applied to ordinary gas producers, both in the United States and in Germany but not so much in England. This mechanical action involves agitation in the fuel and ash zones of the producer and mechanical ash removal. Many attempts in this direction of mechanical action have previously been made and some of them have met with more or less success. The writer

believes the first of such proposals was made by E. J. Duff, who designed an octagonal-section revolvable producer with a stationary grate, ash trough and top, as shown in Fig. 14. This design was disclosed in British Patent No. 15,646 of 1901, but the specification does not state that it was intended for ammonia recovery purposes, although, as far as the author's recollection goes, the inventor considered it primarily in this connection. The writer is unaware of any practical trial having been made of this producer.

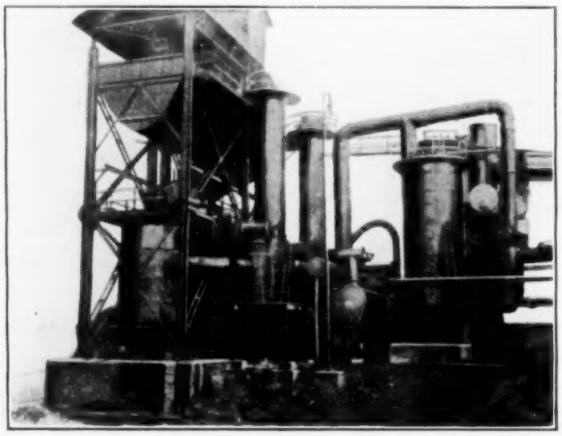

Fig. 18 First Section of a 13,000 H.P. Lymn System Producer Gas and By-Product Recovery Plant

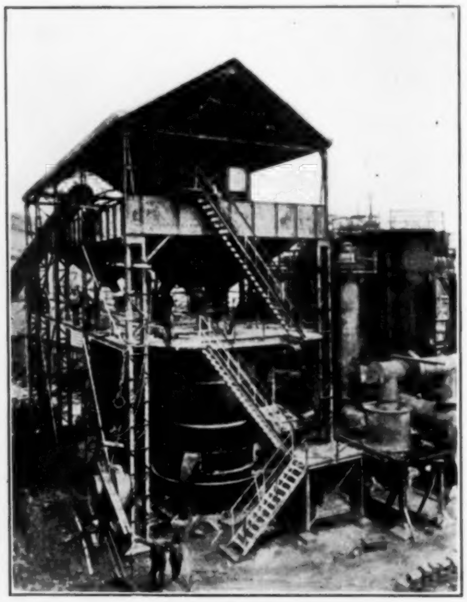

Fig. 19 5000 H.P. Lymn System Producer Gas and By-Product Recovery Plant During Erection

The next of these proposals was a combination of the well-known Talbot stirrer with the Mond producer. This was made by Dr. Mond himself and is shown in Fig. 15. This apparatus was tried out thoroughly with various coals of a more or less coking nature. It was very costly to install and its operation was not without difficulties. The writer does not know of any more producers of this type being built beyond the first.

Another attempt to adapt revolving producers to ammonia recovery plants was one made by the author, but although its trial was much hampered by the fact that the makers failed to build the device to drawings and specifications, it was certainly not sufficiently successful to warrant general adoption. The great depth of fuel requisite for ammonia recovery renders the operation of mechanical producers exceedingly difficult. One of the difficulties found by the writer in practice was that, when using a caking coal, the producer revolved while the coal remained more or less stationary, resulting only in the grinding of the coal at the periphery of the producer.

Another step in this direction was the combination with the producer of the mechanical ash removing apparatus designed by Mr. Trump. This combination is illustrated in Fig. 16 and has been adopted on a somewhat large scale. A battery of these so-called Mond-Trump producers was built in England and at the time of its installation the writer was hopeful that the combination, though very costly, would prove to be a valuable development; however, the information to hand regarding it is not very encouraging.

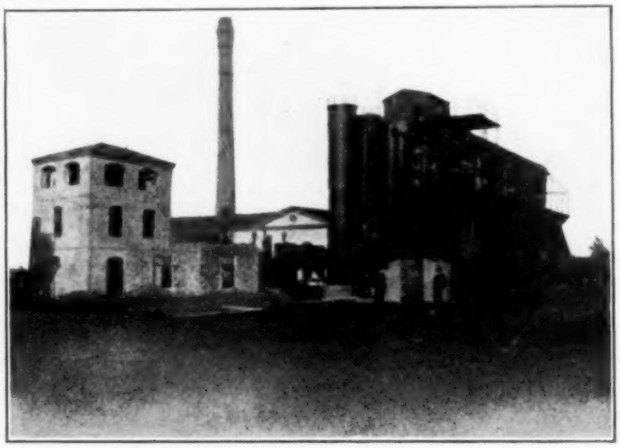

Fig. 20 Peat Power Gas Plant with Ammonia Recovery at Pontedera, Italy

Still another proposition is that made by A. B. Duff, in which a mechanically operated stirring poker is utilized in the producer (Fig. 17). This worked very well indeed when tried with Scotch washed nut and the writer believes it has been further adopted for use with this or similar coals. Scotch coal does not cake, however, and therefore with such coal there appears to be insufficient justification for incurring the additional cost of this stirring gear, except it be for the purpose of increasing the rate of gasification. The writer has had a great deal of experience with Scotch nut in stationary producers and has never had the slightest trouble with this coal. He would therefore be interested in the results obtained with this device when applied to English caking coals, and still more to those in this country.

The design of producer adopted in the Lymn plants was based on the principle which has been so largely utilized for ordinary hot gas producers in Europe, where the rotary grate and the mechanical ash removal have been further constructionally improved and very widely introduced both by Kerpely of Vienna and by the writer's German licensees. On the basis of the last-named firm's designs as adopted for hot gas producers, the system has been applied to ammonia recovery, material modifications being of course necessary.

TABLE 1 ACTUAL OPERATING RESULTS OF POWER GAS PLANT (LYMN SYSTEM)

DRIVING LARGE GAS ENGINES AND FIRING FURNACES

First period of 4 weeks	Total	Average per day of 24 hours	General Average
Coal consumption of the gas plant	1,806 tons	64.6 tons	Per kw-hr. 1.58 lb. (0.72 kg.).
Power produced (kw-hr.)	1,889.740	....	Per hr. 2812 kw.
Yield of sulphate of ammonia	49.11 tons	1.76 tons	Per ton coal 60 lb. (27.1 kg.)
Yield of tar (containing water)	189.7 tons	6.78 tons	Per ton coal 230 lb. (105 kg.)
Average heating value of the gases	155 B.t.u. per cu. ft. (1380 cal. per cu. m.)		
Sulphur contained in the gas (average)	0.63 grams per cu. m.		
Tar contained in the gas (average)	0.04 grams per cu. m.		
The auxiliary machines consumed regularly 71 kw.			
Including 10 per cent depreciation the gas costs per kw-hr. work	out at 0.069 penny		
Second period of 4 weeks			
Coal consumption of the gas plant	1,967 tons	70.2 tons	Per kw-hr. 1.72 lb. (0.78 kg.)
Power produced (kw-hr.)	1,899,600	....	Per hr. 2830 kw.
Yield of sulphate of ammonia	54.3 tons	1.94 tons	Per ton coal 61 lb. (27.6 kg.)
Yield of tar (containing water)	231.7 tons	8.27 tons	Per ton coal 257 lb. (117 kg.)
Average heating value of the gases	154 B.t.u. per cu. ft.		
Sulphur contained in the gas (average)	0.38 grams per cu. m.		
Tar contained in the gas (average)	0.057 grams per cu. m.		
The auxiliary machines consumed regularly 78 kw.			
Including 10 per cent depreciation the gas costs per kw.-hr. work	out at 0.07 penny		

NOTE:—The nitrogen efficiency during these two periods was 70 per cent. It is frequently 75 per cent.

TABLE 2 ESTIMATES OF WORKING COSTS FOR (I) A 2000 H. P. POWER GAS INSTALLATION, (II) A 4500 K. W. PRODUCER GAS PLANT, AND (III) A PRODUCER GAS PLANT FOR CONTINUOUS GASIFICATION OF 500 TONS OF COAL DAILY

CONDITIONS LOAD CONDITIONS OF PLANT	I Power	II Power	III Heating
Hours of full load per annum	4000	8500	8760
Size of plant in b.h.p. or kw. or long tons of coal per day	2000 b.h.p. (1350 kw.)	6600 b.h.p. (4500 kw.)	500 tons
Cost of coal in dollars per short ton	2	1	2
Heating value of coal in B.t.u. per lb.	12,600	12,600	12,600
Nitrogen content of coal in per cent	1.3	1.3	1.3
Cost of sulphuric acid (140 deg. Twaddell) in dollars per short ton	9	9	9
Value of sulphate of ammonia in dollars per short ton	55	55	55
Value of tar in dollars per short ton	5	5	5
Heat consumption of gas engines in B.t.u. per kw-hr.	14,900	14,300	...
COST OF PLANT			
Producer power gas and ammonia recovery plant (Lymn System) in dollars	40,600	126,500	605,000
Buildings and foundations for same	4400	12,000	55,000
Complete gas engine installation consisting of gas engines, dynamos, all auxiliary machines, exhaust boilers, overhead crane, etc., in dollars	88,000	335,500 (spare set of 2250 kw.)	...
Buildings and foundations in dollars	13,000	48,000	...
Total Cost of Installation	138,000	522,000	660,000
WORKING DATA			
Amount of kw-hr. per annum	5,400.000	38,250.000	...
Tons of coal used (including stand-by losses) per annum	4830	29,840	204,400
Tons of sulphate of ammonia recovered per annum	206	1346	9210
Tons of tar recovered per annum	230	1500	10,500
Tons of sulphuric acid consumed per annum	190	1280	8800
Rate of amortization on machines and plant in per cent per annum	12	12	12
Rate of amortization on buildings and foundations in per cent per annum	6	6	6

	I Power	II Power	III Heating
ANNUAL WORKING COSTS IN DOLLARS OF PRODUCER GAS AND AMMONIA RECOVERY PLANT (LYMN SYSTEM)			
Cost of coal	9660	29,840	408,800
Labor	5600	16,630	49,500
Repairs and maintenance	1230	3780	18,000
Oil, waste, lighting, etc.	680	2990	15,330
Sulphuric acid	1710	11,520	79,200
Depreciation and interest	5132	15,900	75,900
Total debit	24,012	80,560	646,730
Credit by sulphate of ammonia	11,330	74,030	506,550
Credit by tar	1150	7500	52,500
Total credit	12,480	81,530	559,050
Total annual cost of gas	11,012	970 Profit	87,680
Cost of gas in cents per 1000 cu. ft. (heating value 150 B.t.u. per cu. ft. net)	2.10	0.03	0.32
ANNUAL WORKING COSTS OF GAS ENGINE PLANT (Based upon first class German Gas Engine practice)	Dollars per Annum	Dollars per Annum	
Cost of gas as above	11,012	970 Profit	
Repairs	1250	5170	
Oil, waste, water	840	4420	
Labor at American rates	3590	10,370	
Depreciation and interest	10,380	3180	
Total costs	27,072	62,170	
Total cost of power in cents per kw-hr.	0.50	0.16	
Total cost of power in dollars per kw-year	....	13.80	
Total cost of power in dollars per h.p.-year	....	10.30	

These modifications are to provide a vastly increased volume of air and steam, a deeper fuel bed, superheating of the blast of air and steam, increased pressure of the air blast and consequently deeper water lute, etc. Plants on this system have been built by the Badische Anilin und Soda-Fabrik, of Ludwigshafen (Fig. 18), and by the German Government at Heinitz (Fig. 19). Several others are under construction. These represent the latest type of Lymn plant adopted in large scale practice.

The plants in operation have worked well and a resumé of the operating results of one plant is given in Table A. These results are taken from the daily log sheets of a plant now gasifying about 80 tons of coal per 24 hours, the gas being used for driving four 1300 h.p. gas engine electric sets and also for firing furnaces. The coal in use is common slack and brown-coal at an average price of 12 to 13 shillings per ton. The heating value of the coal is 10,400 B.t.u. per

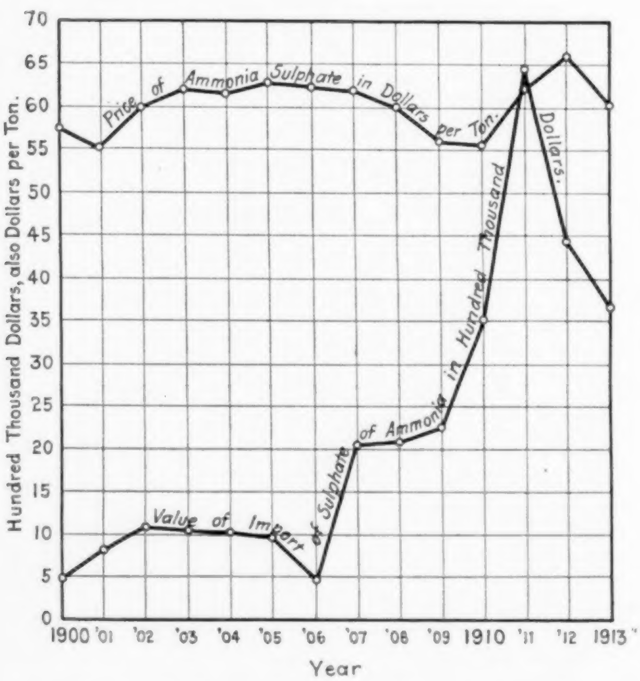

FIG. 21 VALUE OF U. S. IMPORTS AND PRICE FLUCTUATIONS OF AMMONIUM SULPHATE 1900–1913

lb. (6000 kg. cal. per kg.) and the nitrogen contained in the coal averages 0.80 per cent. These records cover two periods of four weeks, each being selected quite haphazard. In spite of the high cost and low nitrogen content of the coal, the cost of gas per kw-hr worked out at only 0.55 pfg. or 0.13 cents, is an interesting result.

There is one point in connection with this industry which I think deserves considerable attention. It is well known that the amount of steam generally used in these plants with normal coal is approximately $2\frac{1}{2}$ tons for every ton of coal gasified. Of this amount, up to two-fifths is recovered from the heat of the gases (i.e., during the gas cooling and air saturating cycle of operations) in a modern and properly designed plant. The remainder, $1\frac{1}{2}$ tons, has, however, to be made by direct coal-fired boilers or other means. Needless to say the provision of separate boilers involves a considerable charge on the operating costs of the plant, and it should therefore always be one's endeavor to obtain as large a quantity of steam as possible in the form of waste steam at practically atmospheric pressure (which is quite sufficient) or to raise such steam by utilizing waste heat.

In connection with gas power plants, the steam can be made by utilizing the heat of the exhaust gases from the gas engines. This is a problem to which the author has devoted considerable attention, and in the plant referred to above, all the steam is produced in special boilers of his own design which are heated by the exhaust from the gas engines. In this particular installation there are four boilers, each attached to a 1300 h.p. gas engine, and each raising 2 to 3 lb. of steam per h.p.-hr. This amount of steam is 25 per cent more than that required for the gasification of the coal.

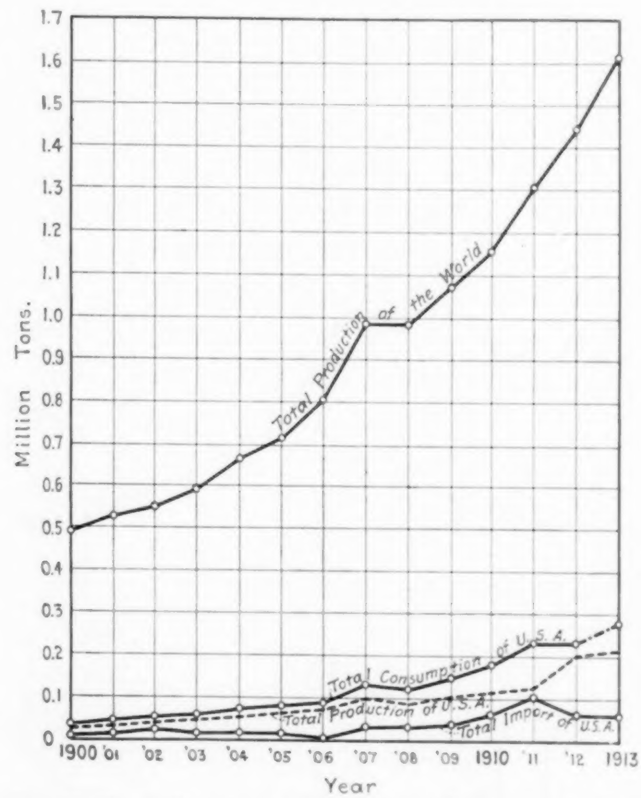

FIG. 22 TOTAL PRODUCTION OF AMMONIUM SULPHATE AND CONSUMPTION IN THE UNITED STATES

It may be suggested that when boilers are utilized for this purpose there is danger of corrosion, but four years' full-time operation is sufficient criterion that this is not so. The writer's experience is that satisfactory operation is merely a question of properly dimensioning the boilers.

The above mentioned plant is the first in the world to be absolutely self-contained as far as steam is concerned and great strides are now being made in the Lymn plants in the matter of utilizing the heat of waste gases from all kinds of operations for the production of steam.

It might be of interest here to give some particulars of the largest gas engines, just ordered from Messrs. Ehrhardt and Sehmer by the Farbwerke Hoechst, Main, which will be coupled to a Lymn plant consisting of five producers. The three engines are each of 4500 h.p., run at 94 r.p.m., and have only two cylinders, each of 1330 mm (4 ft. $4\frac{1}{2}$ in.) diameter and 1400 mm (4 ft. 7 in.) stroke.

In regard to the utilization of the gas for steam rais-

ing purposes there is a great deal to be said, but it will merely be mentioned that the efficiencies which may be realized in well-constructed plants are from 70 per cent upwards (indeed in the Bone system efficiencies of 90 per cent or more have been actually achieved in the writer's presence). Considerable development in this direction of high efficiencies of gas-fired boilers is looked forward to, and the writer has applied in most countries for patents on a different system for achieving similar results to Bone.

At all events, it is important to realize that where coal is expensive gas engines are obviously the more economical to adopt, and where coal is cheap the by-products more than pay for the coal and the gas can be made for nothing or even at a profit. In the latter case, it does not matter very much what quantities of gas are used per h.p., and under such circumstances gas-fired steam plants become as profitable as gas engine plants or more so.

To give a general idea of the adaptability of ammonia recovery plants for power as well as for heating purposes, three estimates of working costs have been made for (I) a 2000 h.p. power gas installation, coupled together with gas engines and working 4000 hr. per annum, (II) a 4500 k.w. producer gas plant, coupled together with gas engines and dynamos furnishing current for say electrochemical purposes, working 8500 hr. per annum, and erected near a colliery where the coal will be cheap, and (III) a producer gas plant for a daily and continuous gasification of 500 tons of coal, the gas being used say for firing steel furnaces. The estimates are given in Table B. The working costs of these three plants are based upon the actual results in practice referred to above. It has been assumed that the cost of labor is 50 per cent and the cost of apparatus is 25 per cent more than in England and Germany.

It will be realized that for industries such as electrochemical plants requiring a large amount of power, it is quite unnecessary to have recourse to water powers which are almost invariably situated in localities quite unsuitable as manufacturing sites and which therefore require long, costly and unreliable transmission systems subject to the dangers of sleet, wind and electrical failures. Every power user who depends upon an uninterrupted supply of current for the success of his operations would gladly dispense with this transmission, even were its high cost of no importance.

In considering the development of ammonia recovery plants, the statements made so far have referred to the treatment of coal, which is obviously the most used combustible. They may also be taken, however, as applying to waste coal containing a high percentage of ash, as well as to other poor grade coals, such as lignite, coke breeze, etc.

Coke breeze, as obtained in the manufacture of lighting gas, has now a particularly advantageous application in these plants. It is well known that as a general rule the retorts in gas works are heated by means of good trade coke which has a high selling value, but the coke breeze which is sieved out is practically a waste product. This substance can now be dealt with, producing all the gas for firing the retorts together with about 60 lb. (value $1.20) of sulphate of ammonia per ton of breeze. Furthermore, much good coke is thus set free for sale to the public at a high value. A large plant is already operating on these lines in England and is very successful and profitable.

There are, however, other combustibles whose use in producer plants is restricted on account of the high percentage of water they contain. Such in particular are peat and wet brown-coal.

The writer, as technical manager to The Power-Gas Corporation was able to apply successfully the Mond Gas process to the treatment of peat between 1904 and 1907. The drying of peat is a most difficult matter and in view of this fact it is interesting to note that today it is possible to produce regularly power gas and by-products from peat containing up to 60 per cent water. This peat can be obtained by relatively short periods of drying in the atmosphere in

TABLE 3 THE NITROGEN CONTENT OF AMERICAN COALS

State	Amount of coal samples analysed for nitrogen content	Average content of nitrogen in per cent on theoretically dry fuel
Alabama	37	1.42
Alaska	45	1.14
Arizona	1	1.25
Arkansas	18	1.41
California	4	0.97
Colorado	176	1.36
Georgia	1	1.13
Illinois	67	1.28
Indiana	23	1.27
Iowa	15	1.16
Kansas	30	1.24
Kentucky	22	1.42
Maryland	15	1.71
Michigan	2	1.38
Missouri	40	1.11
Montana	81	1.03
New Mexico	27	1.29
North Dakota	6	1.15
Ohio	15	1.30
Oklahoma	20	1.63
Oregon	1	1.42
Pennsylvania	106	1.28
Rhode Island	10	0.19
Tennessee	15	1.46
Texas	5	1.16
Utah	32	1.11
Virginia	27	1.29
Washington	169	1.58
West Virginia	265	1.37
Wyoming	192	1.30
Total	1467	....
Average	...	1.325

practically all countries. Evidences of success in this matter are the facts that a 20-ton plant was erected in Germany, some years ago to demonstrate the advantages of this process, and another plant (Fig. 20) dealing with 100 tons of peat per day and producing sulphate of ammonia and power gas has been in operation in Northern Italy for about three years. In the latter case a further peat bog has now been purchased and a second and larger plant built upon it. The writer, too, has entered into a contract for building in Russia a plant of this type to treat 90 tons of peat (stated as theoretically dry) per 24 hr.

The quantity of ammonium sulphate produced per ton of peat depends upon the nitrogen content and varies between 70 and 220 lb. per ton of dry peat gasified. Where peat with about 2 per cent nitrogen is available, one can obtain a large profit simply from the ammonium sulphate, regarding the gases as a by-product. Indeed, with peat which contains

little nitrogen, gas can in most cases be produced without cost. Other by-products which can be produced from peat are tar (which contains much paraffin), also acetate of lime, etc.

The application of the Mond process to peat as worked out in England has at times been erroneously referred to as the Frank-Caro process. As a matter of fact, however, only one plant was built according to Frank and Caro's designs. This was at Osnabruck, Germany, and it was shut down after twelve months' operation.

In conclusion, the By-Product Producer Gas industry has not been exploited to the same extent in the United States as in Europe, and one object of this paper has been to bring before the engineers of this country the facts relating to an established industry the great advantages of which are at their disposal. These advantages are well recognized in Europe and in other parts of the world and it seems almost an irony of fate that the United States has benefited so little from them.

The author's long experience in Great Britain, Germany and other countries with many kinds of fuel, from peat to brown-coal and from anthracite to the most bituminous coals, does not, however, lead him to dogmatize upon the utilization of the vast range of fuels in this country in plants which have so far been used almost entirely elsewhere. Indeed he is well aware that mistakes have been made in this country in the past by adopting *en bloc* European designs. It might be of interest to know that a plant of his design already modified to suit the local conditions is now being extensively experimented with at an important colliery in the Pittsburgh region and trials on a large scale of all qualities of coals, from waste roof coal upwards, are now being very thoroughly carried out in a Lymn Plant under the direction of Lewis A. Riley, 2d, member of the Society.

About fifty By-Product Producer Gas Plants are already built having a yearly fuel capacity of approximately 2,000,000 tons. These are distributed among Great Britain (which has most of them), Germany, Italy, Spain, China, Japan and this country. The total yearly fuel capacity of them all is close upon two million tons. The gas from them is being used not only for power production but also for all kinds of industrial heating operations, such as reheating furnaces, forging furnaces, annealing furnaces, steel furnaces, core stoves, crucible heating, galvanizing baths, gas works retort firing, spelter furnaces, glass works operations, evaporating brine, calcining operations, roasting operations, distilling operations, heating drying rooms, etc.

It may be contended by many that the adoption of a large number of ammonia recovery plants would run down the sulphate of ammonia market, but it must be borne in mind that in England, where by-product producer gas plants have made more progress than in all other countries together, the proportion of sulphate of ammonia made by this means amounts to only 13 per cent. The remainder comes from lighting gas plants and coke ovens which in Germany, and also to a great extent in England, are producing nearly as much sulphate of ammonia as is possible.

The consumption of sulphate of ammonia is steadily on the increase, although the market has fluctuated considerably during the past year. This substance must therefore be supplied from other sources than those which have so largely supplied it up to now. The author has personally considered this question somewhat closely with reference to the production of nitrogenous fertilizers and is convinced that there is room for a very large increase in the production of sulphate of ammonia from gas producer plants, in spite of the increasing production of synthetic nitrogenous fertilizers.

In this connection Figs. 21 and 22, showing the imports and price fluctuations as well as the comparative production of ammonium sulphate in this country over the period from 1900 to 1913, might be of interest. In considering these data it should be borne in mind that the quantities represented form only a part of the whole nitrogenous fertilizer trade, which comprises, in addition to ammonium sulphate, nitrate of soda, calcium cyanamide, nitrate of lime, guano and animal waste generally.

Regarding the nitrogen content of American coals, Table C represents the average of some 1500 analyses made by that thorough body of workers, the Department of Mines of the U. S. Geological Survey. More than 560 million tons of coal per annum, containing on an average about 1.3 per cent nitrogen, are produced in this country. Imagine this quantity of coal being converted into producer gas and the ammonia recovered from the whole of it, and deduct the amount of sulphate of ammonia which is already produced. The remarkable result is arrived at that about 25 million tons of sulphate of ammonia, having a value of 600 million dollars, are wasted per annum. Surely it is worth while to consider recovering at all events a small portion of this, especially when it is realized that every dollar spent by agriculturists in sulphate of ammonia means crops.

MODERN STEELS AND THEIR HEAT TREATMENT

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Non-Member.

STEEL is an alloy. In its most simple form it is made up of two components: iron and a carbide of iron technically known as cementite. Commercial steel always has at least four other elements present: phosphorus, sulphur, manganese, and silicon, but the total amount of these four elements contained in an ordinary commercial steel is less than 1 per cent, and the influence of the average variation in all of these impurities upon the physical properties of the steel, is slight compared with the effect of the carbon.

The carbon is the main factor in influencing variations in the physical properties. It varies from practically nothing in wrought iron to about 1½ per cent in high carbon tool steel. A variation of 0.1 of 1 per cent of carbon will affect the tensile strength of annealed steel about 8000 lb. per sq. in. The carbon exists as cementite, which is fifteen times as heavy as the carbon of which it is composed. In steel this cementite occurs intimately mixed with about 6½ times its own weight of iron. One part of carbon, therefore, makes up about 112½ parts of this mixture, which is known as pearlite. A steel containing 0.1 per cent carbon is really composed of about 11 per cent pearlite and 89 per cent of iron.

A sample of iron, magnified to 150 diameters, shows about 0.01 per cent carbon, which makes the structure 1 per cent pearlite and 99 per cent iron. This pearlite is not visible under this magnification, and, therefore, the material has the appearance of pure iron. As the carbon increases the pearlite areas become larger and the amount of iron smaller. A microscopic photograph of a steel containing 0.20 per cent carbon shows about 22 per cent pearlite.

Another sample with a still further increase in carbon to 0.40 per cent shows 45 per cent pearlite and 55 per cent iron. Similarly, an 0.80 per cent carbon steel, contains 90 per cent pearlite and 10 per cent iron, while in a 0.90 per cent carbon there is no excess iron and, therefore, 100 per cent pearlite.

As the carbon increases above the point necessary to form 100 per cent pearlite it must necessarily exist as free cementite, as all the iron has been taken up to form pearlite when the carbon reached 0.90 per cent.

A steel with 1.4 per cent carbon, consists of 92.5 per cent pearlite and 7.5 per cent cementite. A steel containing 2.5 per cent carbon, consists of 24 per cent cementite and 76 per cent pearlite. A steel of this high carbon is rare and has no commercial application. White cast iron, which is the material from which malleable iron is made, is an impure steel of a carbon content similar to this.

Briefly summarizing the structural condition of a series of steels of various carbon contents, we see that one containing 0.9 per cent carbon consists of 100 per cent pearlite. This steel is known as saturated, or, commonly, an eutectoid, steel. A steel containing less than 0.9 per cent carbon contains pearlite and iron. It is known as an undersaturated or hypo-eutectoid steel. A steel with more than 0.9 per cent carbon is known as super-saturated or hyper-eutectoid steel; it contains pearlite and cementite.

When a piece of steel is pulled apart in a tensile machine the cross-sectional area at the point of fracture is less than that of the original bar. The amount of this difference is known as the "reduction in area," and it is a fair measure of the toughness of the steel. While the meaning of the term "toughness" is open to more or less dispute, we can consider it as the ability of the metal to distort without causing fracture. For example, a steel which can be bent through an angle of 75 deg. before fracture is tougher than one which can be bent only 25 deg.

If tensile tests are made on a series of steels of increasing carbon contents we find that the tensile strength increases with the increase in the amount of pearlite, but the toughness decreases.

The tensile strength of iron is about 40,000 lb. per sq. in. This can be increased by about 700 lb. for each increase of 1 per cent pearlite. The reduction in area for pure iron is about 80 per cent and this is decreased by about 0.5 per cent for each increase of 1 per cent pearlite. For ordinary structural purposes a steel which is subject to vibration or shock is not safe with much less than 50 per cent reduction in area. From these figures it is readily calculated that a steel with 60 per cent pearlite, which corresponds to about 0.55 per cent carbon, has a reduction in area of about 50 per cent. Such a steel has a strength of approximately 80,000 lb. per sq. in.

Evidently, then, the strength of a steel subjected to dynamic stresses can be safely increased up to 80,000 lb. per sq. in. by the use of an increased carbon content; however, every additional increase in strength is obtained at the expense of the toughness. A further consideration is the fact that the hardness of the steel, and therefore the difficulty and expense of machining, increases with the pearlite.

A little consideration of the above facts will show that they are logical and what should be expected. The pearlite is composed of fine plates of pure iron strengthened and made rigid by cementite, which itself is intensely hard and strong, but very brittle.

The pearlite, as a mass is strong, but, due to the cementite in it, it is not as tough as pure iron. Pure iron compared to pearlite is weak but tough. A combination of the two will give characteristics consistent with the proportion of the constituents.

It is apparent that in order to obtain greater strength on the steel without increasing the amount of pearlite, or, what is the same thing, the amount of carbon, at least three things can be done: (1) increase the strength of the iron, (2) increase the strength of the pearlite, or (3) increase the strength of both. Practically, these are reduced

[1] The Peerless Motor Car Company.

Abstract of paper presented at a joint meeting of the Philadelphia local section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS and the Franklin Institute on January 14, 1915. This paper was published in full in the Journal of the Franklin Institute, April, 1915, to whom we are indebted for the use of the illustrations.

to two, because anything which increases the strength of the iron also increases the strength of the pearlite to some extent, because of the iron in it.

This can be accomplished by adding to the steel some element or elements which will alloy with either the iron, the pearlite, or both, and increase their strength. A steel containing this extra element is known as an alloy steel. There are two classes of alloy steels: those in which one or more of the normal impurities are made abnormally large, and those in which one or more elements not normally present are added. To the first class belong silicon and manganese steels. To the second class, which is the more important commercially, belong nickel, chrome, chrome vanadium, chrome nickel, tungsten, and titanium steels.

As typical examples of the two methods of increasing the strength of steel, nickel and chrome steels may be considered. Nickel forms a solution or alloy with the iron

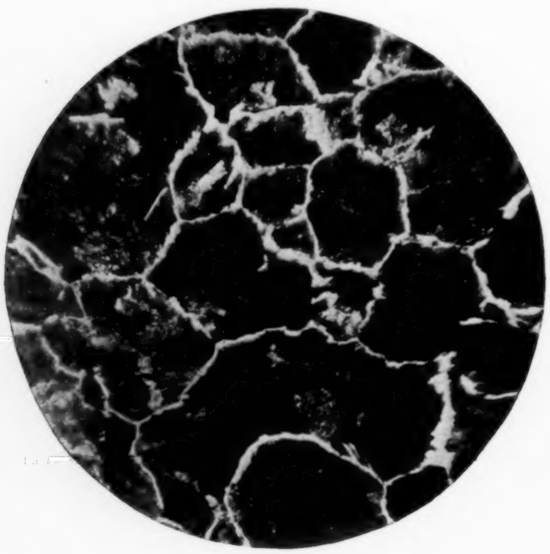

FIG. 1 STRUCTURE SHOWING CEMENTITE AND PEARLITE, 1.4 PER CENT CARBON (150 DIAMETERS)

which is stronger than iron alone. Chromium replaces some of the iron of cementite, forming a carbide of chromium. The pearlite thus formed from the double carbide of chromium and iron is stronger and at the same time tougher than ordinary pearlite formed without chromium. The most widely used nickel steel contains $3\frac{1}{2}$ per cent nickel, while the common chrome steel has about 1 per cent chrome. Such a nickel steel will be about 20,000 lb. per sq. in. and chrome steel about 15,000 lb. stronger than a simple steel of the same carbon content. At the same time the toughness of the nickel steel will be about the same as that of a simple steel, while for the chrome steel it will be a little greater. It is apparent, then, that the use of an alloying element to increase the strength of steel is better than to use carbon for the same purpose, as the increased strength is not obtained at the expense of the toughness.

Thus the relation between strength and toughness in ordinary steel can be varied by changing the relative amounts, and also the strength or toughness of two substances composing it; namely, the pearlite and iron. In either case this must be done by adding something to the steel: in the first case, carbon, and, in the second, some alloying element. Can we not change the relative amounts of the elements or their strength by some process of heating?

Consider the steel containing 0.20 per cent carbon, which forms about 22 per cent pearlite. If we heat this to a temperature of 1000 deg. fahr. and suddenly cool or quench it in cold water, it will be found that neither its physical properties nor its appearance under the microscope has been changed; if the temperature is increased to 1100 deg., still no change is found; nor will any difference be detected until a temperature of about 1375 deg. fahr. is reached, when it will be found that the iron is still present and in about the same amount, but the pearlite areas have become more or less rounded. If examined under 1200 diameters, it will be found that the white areas are the iron, while the dark areas represent what was originally pearlite; it has now apparently coalesced, so that the original cementite and ferrite of which it was composed have merged into a single substance.

The real explanation of the change which has taken place is that the iron which originally composed part of the pearlite underwent an allotropic change at this temperature, and in its new form it is capable of dissolving to a solid solution the cementite with which it was in contact. This new solid solution is known as austenite, and by the sudden quenching, time is not given for the reverse allotropic change to occur completely. It cannot be entirely prevented, and the transition substance which we really obtain is known as martensite.

A steel thus treated is different from the untreated steel in one of its constituents, and is made up of iron and martensite instead of iron and pearlite. Martensite is much stronger but more brittle than pearlite. We should then expect that our treated steel should be stronger but less tough than the one not treated. The untreated steel has a tensile strength of about 55,000 lb. per sq. in., and a reduction in area of 65 per cent. The same steel heat treated as just explained has a tensile strength of about 95,000 lb. per sq. in., and a reduction in area of about 30 per cent. These properties are very similar to those of a high carbon steel containing about 100 per cent pearlite or 0.90 per cent carbon. In other words, by a simple process of heat treatment, we can obtain with a 0.20 per cent carbon steel the physical strength of a 0.90 per cent carbon untreated steel.

If at some definite temperature the pure iron in the pearlite went into a solid solution with the cementite, possibly at a still higher temperature, more of the iron could be caused to go into such a solution. A photograph of the structure of the same steel quenched from 1440 deg. will show that the iron has decreased in amount, while the martensite has increased. Apparently then, as the temperature is raised, the saturation point of the martensite for iron is increased; just as in a water solution more sugar can be caused to dissolve by increasing the temperature.

At a temperature of 1565 deg., all of the iron will go into solution and the quenched steel will consist of 100 per cent martensite. A high magnification (1200 diameters), shows the martensite structure to be triangular. Thus, it is seen that as the steel is subjected to an increasing temperature of quenching, the amount of iron constantly decreases until

it becomes zero, while with the increase of carbon, the pearlite increases to 100 per cent and with the increase of temperature, the martensite increases to 100 per cent.

With the increase of temperature, the strength increases, beginning with the temperature of the first change, until final absorption of the iron, while the toughness also increases if the carbon is low. Table 1 illustrates this more fully:

TABLE 1. VARIATIONS IN STRENGTH AND TOUGHNESS IN UNTREATED AND HEAT-TREATED STEELS

Untreated steel			Heat-treated steel, 0.20 per cent carbon		
Per cent pearlite	Strength	Toughness	Per cent martensite	Strength	Toughness
25	55,000	65	25	95,000	30
50	75,000	55	50	98,000	40
75	90,000	45	75	100,000	50
100	105,000	35	100	105,000	55

The temperature at which the pearlite first changes is known as the lower critical temperature, and the temperature at which the absorption of iron is complete is known as the upper critical temperature. It is apparent that of two steels containing different percentages of carbon, and therefore different percentages of pearlite, the one containing the more pearlite will have less iron to dissolve, and therefore the temperature of final absorption will be lower. In other words, the upper critical temperature is lowered by an increase in the carbon content. If the steel is all pearlite, *i.e.*, contains 0.90 per cent carbon, its upper and lower critical temperatures will coincide.

With some steels the best results are obtained by quenching just at the absorption point, while with others a higher temperature is necessary. The metallurgist must know the amount of this variation for different types of steels.

The heat treatment of an alloy steel is exactly the same in principle as that explained above for plain carbon steels, the alloying elements giving increased strength as well as increased toughness to the heat treated, in the same manner as it did in the untreated steel.

From the foregoing, it is apparent that a steel heat-treated to bring out high strength, will consist of 100 per cent martensite, no matter what amount of carbon there was originally present, or whether alloying elements were there or not. Evidently then, martensite will have a varying composition. Under the microscope there is very little difference in appearance, no matter what the composition. Since martensite is really formed from a solution of cementite in iron, a high-carbon steel will form a stronger solution than a low-carbon one, just as a strong or weak solution of salt can be had in water. Alloying elements in the martensite do not cause any difference in its structure any more than a little sugar would cause a difference in the appearance of a salt-water solution. These alloying elements, however, have a very decided influence upon the position of the critical temperature; for example, 0.1 per cent manganese lowers the upper critical temperature 6 deg., while it has practically no effect upon the lower critical temperature; 0.1 per cent chromium raises the lower critical temperature 4 deg. when nickel is absent, but with nickel present it raises it only 3 deg., but in neither case does it have any appreciable influence upon the upper critical temperature. The business of the metallurgical engineer is to know absolutely the influence of all elements upon these critical temperatures.

In general, these martensites made from a steel containing more than 0.2 per cent carbon have not enough toughness for their strength, and to remedy this, the steel is given a second low heat, commercially known as a drawing heat, which allows a certain amount of transformation to take place in the martensite, and reduces its strength but increases its toughness. By varying the final heat, an unlimited number of combinations of strength and toughness are available. As the drawing temperature is raised still higher the micro-structure of the steel becomes extremely fine and it is known as sorbite. This is really an imperfect pearlite intimately mixed with iron.

Broadly summarized, the process of heat treatment consists in transforming an alloy from a mechanical mixture of two substances into a homogeneous solution of a single sub-

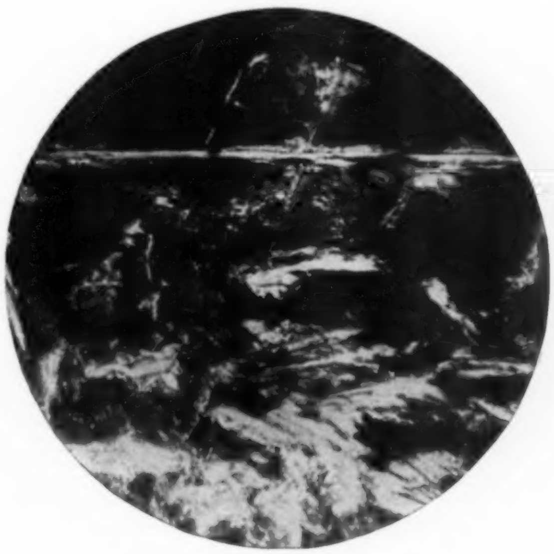

FIG. 2 STRUCTURE SHOWING CEMENTITE NEEDLES (350 DIAMETERS)

stance. This very fact gives to a heat-treated steel one of its most valuable advantages over the untreated steel; namely, its ability to withstand repeated shocks or vibrations, or, as it is popularly expressed, "fatigue-resisting power." The reason is obvious: an alloy composed of two dissimilar substances has mechanical boundaries between them. This fact is a source of weakness under repeated stresses, the reasons for which are more or less complicated. An untreated steel contains these boundaries; a correctly heat-treated steel does not.

There is a still further advantage based upon a different consideration. A steel with a tensile strength of, say, 60,000 lb. per sq. in., if subjected to repeated reversals of stress of any magnitude, will finally break after a definite number of these reversals; as the magnitude of these stresses approaches the actual strength of the steel, the number of reversals necessary to cause a break rapidly decreases; as a consequence of this fact, a comparatively slight increase in the strength of a piece of steel will increase way out of proportion its resistance to fatigue break. Therefore, it is frequently desirable to heat-treat a piece of steel to give it

an added factor of safety under shock or alternate stresses, even though its static factor of safety is sample.

In supersaturated steels,—that is, those containing more than 0.90 per cent carbon, we have present cementite and pearlite. Most tool steels belong to this class. In the heat treatment of such a steel, the pearlite changes to austenite at the same temperature which we found for an undersaturated steel. As the temperature is raised above this point, the excess cementite begins dissolving into this austenite, just as the iron did in a lower carbon steel, until at a definite temperature all of it is dissolved, and we have, as before, austenite. The cementite is more sluggish in dissolving into the austenite than the iron, and the reaction requires more time to complete. As we have previously seen, cementite is extremely brittle and hard; it occurs usually as sheets in the pearlite or thin envelopes surrounding grains of pearlite. These two types are shown in Fig. 1 (150 diameters) and Fig. 2 (350 diameters). A piece of tool steel which has been previously slowly cooled from above the temperature at which the last of the cementite went into solution will contain the cementite in one of these two forms. If it is hardened at the lowest possible temperature its pearlite will be changed to martensite, while its cementite will be unchanged. These sheets or envelopes of cementite will cause the steel to be extremely brittle, and is a source of many of the troubles of the steel user.

Fig. 3 Structure Showing Cementite Globules (350 Diameters)

Now if the steel is quenched from above the upper absorption point this cementite will be gotten rid of, but the steel is somewhat softer because of its absence. The structure of the steel has also been coarsened by the high temperature, which causes it to be brittle. If the coarsened steel is again reheated slightly above the lowest hardening temperature, the cementite will be precipitated out of the solution, but, instead of being in sheets or plates, it will occur as fine dots, which give extremely good wear and have practically no effect of brittleness. A steel thus treated is shown in Fig. 3 (350 diameters). This same arrangement of cementite can be formed by heating the steel to just above the lowest hardening temperature and holding at this temperature for some time.

In an alloy steel the influence of carbon is reduced, and this reduction is greater the higher the percentage of alloy. For structural purposes the carbon of alloy steels rarely exceeds 0.50 per cent; those containing less than 0.25 per cent are usually used for parts which are to be surface-hardened by the carbonizing process, and above 0.25 per cent for parts which are to be subjected to stresses which do not require a hardened surface.

In the carbonizing process the outer surface of a low-carbon steel has its carbon content raised by heating in contact with carbonaceous material. The depth of penetration of this high-carbon shell and also the percentage of carbon it contains are functions of the carbonizing material used and the temperature and time of carbonization in general; the outer surface should be a supersaturated steel, and therefore its treatment comes under that of tool steel, which we have just considered.

To produce a correctly heat-treated, carbonized article we have four functions to consider: (1) the chemical analysis of the steel; (2) the carbonizing material; (3) the time of carbonization, and (4) the temperature of carbonization. These should be adjusted so that the upper absorption point of the iron of the core shall exceed that of the cementite of the case. Under these conditions, if the steel is quenched from above the absorption point of the core, this will be entirely martensitic, and at the same time the cementite sheet or net of the case will be absorbed, so that it will also be martensitic.

Fig. 4 Core of Carbonized Steel, Single Quench (150 Diameters)

Now in order to obtain the maximum hardness on the surface this cementite must be precipitated, as shown in Fig 3, by a low quench from the hardening temperature. During this second quench the iron of the core will also be precipitated out in practically the same globular form, with this difference; there being more excess iron than excess cementite in the core, the iron will precipitate in larger particles and will not have the characteristic globular appearance.

A comparison of the difference in structure of the core of a piece of carbonized steel with a single hardening heat and this double refining and hardening heat is shown in Figs. 4 and 5. In both cases we have the same amount of martensite (black) and iron (white) present, but the mixture is much more intimate and fine in Fig. 5 (double quench). This increases enormously the toughness of the finished steel.

DISCUSSION

H. V. Wille. The theory of heat treatment has been understood by metallurgists for many years, but this has been largely applied in a practical way only during recent years. Some years ago Dr. Sargeant, who is now connected with the Crucible Steel Company of America, exhibited a small experiment at the Franklin Institute which showed in an interesting way the basis of all heat treatment of steel. He heated in a flame of a Bunsen burner a thin plate until he obtained a red spot. Upon removal from the flame he showed that this spot gradually decreased in brightness until a certain temperature was reached, whereupon the fall of the temperature was arrested and the spot glowed with a marked increase in luminosity, showing that some internal change had taken place in the molecular structure in the steel which caused the elevation in temperature in a manner similar to that produced by the combination of sulphuric acid and water.

If the steel is quenched at this temperature, it will retain its molecular structure, and if examined it will be found that steel so quenched is of maximum hardness, with a less loss of ductility for that particular grade. Furthermore, the molecular structure will not be changed unless the steel is again heated above this critical or recallescence point. It follows therefore that a steel so quenched can be annealed below this temperature without change in the molecular structure, but with a great increase in ductility. A steel so treated has a much higher elastic limit and a much greater reduction of area than steel which has been subject to the ordinary annealing process. The sole advantage of all of the modern high-grade steel consists solely in an increase in the elastic limit, so that the designer is enabled to reduce the weight or size of any detail by the use of a higher unit stress, or to increase the factor of safety by the retention of the same unit stress as in a straight annealed steel.

Extremely high elastic limits can be obtained by the use of the various alloys to assist the hardening effect of carbon, such as nickel and chromium, or of the various tertiary alloys, such as chrome nickel, chrome vanadium, or chrome titanium. Steel can be produced having an elastic limit of 150,000 lb. with sufficient ductility to prevent failure by shock by the use of some of these alloys with proper heat treatment, so that engineers are able to design parts with unit stress as high as 100,000 lb. per sq. in. in place of about 20,000 lb. per sq. in for a straight carbon annealed steel. It is hard to grasp the great benefits derived from this enormous increase in the elastic limit.

I do not, however, feel that the possibilities of the use of straight carbon, heat-treated steel have been utilized to the fullest extent. This condition results from the fact that metallurgists write the specifications to which steel is purchased, and the chief object of the metallurgist is to secure a steel of maximum ductility. The designing engineer, however, is not concerned about the ductility of the steel, but desires a steel having a maximum elastic limit; the manufacturer is unable to produce this steel for the designer because of the ductility requirements in the specification.

Mr. James E. Howard made extensive experiments on tests on rotating shafts. These results showed that the high-carbon, heat-treated steel withstood as many rotations as the more ductile alloy steel, so that it would appear that equally good results could be obtained by the use of the cheaper high-carbon, heat-treated steel as is obtained from the use of the more expensive and more ductile alloy steel. These views seem to be borne out both by the experience of automobile builders and of the railroads. I recall going through the principal automobile factories in France, about

Fig. 5 Core of Carbonized Steel, Double Quench (150 Diameters)

ten years ago, and was shown with a great deal of pride such parts as axles, steering gears, etc., which were bent double because they were made from a very low carbon ductile steel, but the experience of a few years demonstrated an inordinate number of failures from this grade of steel, and the automobile builders then went to the extreme of using the extremely high grade alloy steel, which gave better results, notwithstanding the fact that it possessed less ductility than the carbon steel.

The railroads met with the same experience, and the first experiments in the use of steel in substitution for iron were made with low-carbon steel having the same physical properties as wrought iron. A large number of failures followed this substitution, but they were eliminated by the use of steel having a tensile strength of about 80,000 lb. per sq. in. This grade of steel is successfully used in railroad service, and there is a gradual tendency to go to steel of even higher carbon having a tensile strength of about 110,000 lb. per sq. in. Such steels have been used in an experimental way and have fully proved their value in comparison with the higher-priced alloy steels having greater ductility.

A PROPOSED SYSTEM OF CLASSIFYING AND DIGESTING THE RECORDS OF THE SOCIETY

BY EDWIN J. PRINDLE, NEW YORK CITY

Member of the Society

THE records of the Society contain most valuable information upon every branch of mechanical engineering. They present the results of long experience and deep research of many of the most eminent mechanical engineers in the world. And yet I venture that after a paper has passed from the memory of those who heard it or read it, and the volume of Transactions or number of The Journal in which it appeared has ceased to be current, it has practically ceased to exist so far as usefully serving the Society.

Suppose, for instance, an engineer is at work upon some problem involving a detail of boiler practice. There are probably one or more articles upon the general subject of boiler practice in every one of the thirty-five volumes of Transactions of the Society. His detail of boiler practice may have been treated from several points of view, and if he could readily turn to the volume and page where each particular view of his subject is to be found, he might be led immediately to the solution of the problem. The only way, however, in which he can make certain whether or not his topic has been treated in the records is to go over patiently every page of every paper dealing with boiler practice and the entire discussion of each of these papers, and when he has finished, he may find as a reward for his labors, that the point has never been presented. The extent of the labor and the uncertainty of the result will often cause him not to search the records of the Society at all, but to try to solve the problem himself in the hope that he may reach a solution in less time than the perhaps fruitless search would take.

Clearly, any plan which would enable one to turn immediately to all the information which the Society's records contain upon a particular branch or point of a general subject, would be of the greatest advantage to the practicing engineer, and would save from comparative oblivion the fruits of much brilliant and arduous labor represented in papers in the past Transactions and Journals of the Society.

My suggestion to the Society, consists essentially in adapting to its records, methods of classifying, indexing and digesting, with which I have come in contact in the practice of the law, aided in its application to the records of this Society by the experience of the United States Patent Office in classifying inventions in general, and particularly mechanical inventions.

Until comparatively recent years the "Digests" of volumes of legal decisions have been published in book form, and I here present a portion of the index of such a Digest, under the title "Patents" (Fig. 1).

In order to illustrate the advantage of a system which will bring together the reasoning of several articles on the same general subject, I will show how this particular section of the digest is used. We will suppose that in a patent suit the question arises whether or not the thing shown in the patent amounts to an invention and the bearing on that question of the fact that the sales of the patented article have been large. The point is one which may have been treated in any one of over five hundred volumes of decisions of the Federal Courts. In eight volumes, the digest from which I have reproduced the index on "Patents" covers all Federal decisions upon all subjects since 1880, which occupy three hundred and twenty-five volumes. The subject of "PATENTS" which is treated in about ten per cent of the decisions, is all found in a single volume of this

PATENTS

I. SUBJECTS OF PATENTS.
- § 1. Nature of patent rights.
- § 4. Arts.
- § 6. —— Principles or laws of nature.
- § 7. —— Process or methods.
- §15. Designs.

II. PATENTABILITY.

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- § 17. Nature and degree of skill involved.
- § 19. Enlargement or change in degree.
- § 20. Change of form.
- § 21. Substitution of materials.
- § 22. Substitution of mechanical equivalents.
- § 25. Aggregation.
- § 26. Combination.
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- § 54. —— Unsuccessful and abandoned devices.
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(E) *Prior Public Use or Sale.*
- § 75. What constitutes public use.
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- § 80. Operation and effect.
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(F) *Abandonment.*
- § 82. What constitutes abandonment in general.
- § 83. Delay in making or prosecuting application for patent.
- § 87. Evidence of abandonment.

III. PERSONS ENTITLED TO PATENTS.
- § 90. Original inventors and priority between inventors.
- § 91. Evidence as to originality and priority.
- § 92. Joint inventors.
- § 93. Employers and workmen.

FIG. 1 PORTION OF TYPICAL INDEX OF A LAW DIGEST

Presented at the New York local section of The AMERICAN SOCIETY OF MECHANICAL ENGINEERS, on February 9, 1915.

Digest. Looking at our index of the subject of "PATENTS," the question is one relating to the general subject of the "patentability" of the invention, and to the sub-division thereof of "invention," and it relates to the particular phase of "invention," Evidence of Invention, Sec. 35, Utility and Extent of Use, thus:

"Patentability
 Invention
  Evidence of Invention
   Utility and Extent of Use."

We therefore need to look at Sec. 35 of the subject of "PATENTS." Turning to Sec. 35, we find that it appears as shown in Fig. 2.

Here we find the rulings of four separate courts on cases where the question had been raised whether the thing disclosed in the patent amounted to an invention. The decisions of the Courts (like the papers of our Society) usually contain at least a number of points or subdivisions, each of which may be separately important in the consideration of some particular matter, and therefore each of which points should be the subject of a separate paragraph or

§ 35. —— Utility and extent of use.
See 38 Cent. Dig. Pat. §39.
[a] **(U.S. C.C.A., N.Y.,** 1909)
While commercial success of a patented device may be important on the question of invention and may determine such question, it is not alone sufficient evidence of mental conception, amounting to invention— (C. C.) Fernald v. Oneida Nat. Chuck Co., 167 F. 559, decree affirmed Fernard v. Oneida Nat. Chuck Co., 174 F. 1020, 98 C. C. A. 664.
[b] **(U.S. C.C.A., Ohio,** 1909)
The fact that a patented device overcame defects in prior structures which persons skilled in the art had for several years been trying unsuccessfully to remedy, and went into immediate and successful commercial use, is persuasive evidence of invention.—Electric Controller & Supply Co. v. Westinghouse Electric & Mfg. Co., 171 F. 83, 96 C. C. A. 187.
[c] **(U.S. C.C., N.Y.,** 1908)
The fact that the product of a machine made by a new combination of old elements goes into general use and displaces others is some evidence, of greater or less weight, that the new combination involved invention.—Stafford v. Morris, 161 F. 113.
[d] **(U.S. C.C., Wis.,** 1910)
The great commercial success of a patented device may turn the scale on the question of invention in a doubtful case.—Beckwith v. Malleable Iron Range Co., 174 F. 1001.

FIG. 2 TYPICAL SECTION OF A LAW DIGEST

syllabus, so that each syllabus can appear in its proper place in the classification of the digest. It would be of interest, therefore, to see how one of the decisions we have been considering is digested.

In Figs. 3 and 3a, are shown the syllabi appearing at the head of the text of the last decision of the group of four we have been considering.

It will be noticed that in the parenthesis in the first line of each syllabus is given the number of the section of the digest in which the syllabus belongs, so that one can readily turn to all other decisions upon the same point, in subsequent volumes of the digest, by looking under the section number. Some digests not only furnish this information, but indicate the page of the decision upon which the point can be found to which the syllabus relates. Decisions are sometimes many pages long, and this device enables one to turn immediately to the part of the decision in which he is interested instead of having to hunt through the entire decision.

This system of indexing and digesting law books is very satisfactory when carefully carried out, except that new volumes of digests have to be published from time to time, as new volumes of decisions are issued (which is constantly being done). This requires either a republishing of the digest to combine several volumes in one, or the consultation of each of the several volumes. Of recent years, a digest covering all the decisions relating to "patents" has been published in card index form, which obviates the difficulties just mentioned as it can be constantly brought up to date by the insertion of new cards.

BECKWITH V. MALLEABLE IRON RANGE CO. 1001

Thus far the process of the patent has been treated as requiring the use of a pinch-cock to close the connection between the lamp and the air pump. The claims are, however, broader than the specifications and drawings, and it is contended that they cover a process wherein the connection is closed by any apparatus which does not necessitate the use of heat. Closure without heat is said to be the process of the present patent; closure with heat, the Maglinani process.

But closure was the essential thing of the Maglinani process. Heat was a mere incident. This incident proved troublesome. What was to be done? As already indicated, I think that mechanical skill should have been quite sufficient to answer this inquiry by pointing out that the difficulties arising from a closure with heat should be remedied by a closure without heat—there being appliances old in the art suitable for making it.

Treating the patent as broad in scope or narrow in scope, it is, in my opinion, void for want of invention. It must be borne in mind that this is not a case where special consideration must be given to a simple expedient because it accomplishes a result long sought for, but never attained. There is nothing in the record to indicate that any one other than the owner of the Maglinani process sought to remedy its deficiencies, and this patent was applied for soon after the Maglinani patent was granted.

In my opinion, the decree of the Circuit Court should be affirmed, with costs.

BECKWITH v. MALLEABLE IRON RANGE CO.

(Circuit Court, E. D. Wisconsin. January 21, 1910.)

1. PATENTS (§ 165*)—CONSTRUCTION OF CLAIMS—REFERENCE TO SPECIFICATION.
While the courts lean toward reading into the claims of a patent such limitations as will save the real invention as disclosed by the specification and the prior art, where claims employ broad and nebulous terms for the apparent purpose of enabling the patentee to monopolize an important industry, the claims will not be narrowed beyond the boundaries clearly warranted by the specification.

[Ed. Note.—For other cases, see Patents, Dec. Dig. § 165.*]

2. PATENTS (§ 165*)—CONSTRUCTION OF CLAIMS—"CONVEX" SURFACE.
The word "convex," used in the claims of a patent as applied to a surface, is to be given its generally accepted meaning, ~~as~~ indicating a surface of a more or less spherical form rather than cylindrical.

[Ed. Note.—For other cases, see Patents, Dec. Dig. § 165.*]

3. PATENTS (§ 35*)—EVIDENCE OF INVENTION—COMMERCIAL SUCCESS.
The great commercial success of a patented device may turn the scale on the question of invention in a doubtful case.

[Ed. Note.—For other cases, see Patents, Cent. Dig. § 39; Dec. Dig § 35.*

Utility, extent of use and commercial success as evidence of invention, see note to Doig v. Morgan Mach. Co., 59 C. C. A. 620.]

*For other cases see same topic & § NUMBER in Dec. & Am. Digs. 1907 to date, & Rep'r Indexes

FIG. 3 COMPLETE TYPICAL DIGEST OF A LEGAL DECISION

Each guide card of a main class has a number as well as a name, and the numbers, although not consecutive, are in a progressive order. The numbering of these cards progressively fixes the proper position of each one in the digest as a whole. The leaving of unused numbers between the main guide cards is for the purpose of allowing the introduction of new guide cards in their proper intermediate positions as occasion may arise. The main guide cards are numbered successively, and arranged alphabetically, which enables one to find a proper main guide card quickly. The sub-guide cards under each main card are not only arranged alphabetically, but each one is designated by a letter of the alphabet. These successive letters fix the

relative positions of the sub-guide cards in their main class. This arrangement of numbering the main cards and lettering the sub-class cards enables each syllabus card to be correspondingly numbered and lettered so that it can be correctly replaced after it has been used. Further, the syllabus cards in each sub-class are numbered consecutively, so that it can be told whether or not any card is missing, and, if so, what is its number.

It seems clear to me that the general plan of digesting and classifying the separate points or sub-topics in the

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4. PATENTS (§ 62*)—SUIT FOR INFRINGEMENT—DEFENSES—BURDEN OF PROOF.
In a suit for infringement of a patent, the burden rests on a defendant to prove the defenses of anticipation or prior use beyond a reasonable doubt.
[Ed. Note.—For other cases, see Patents, Cent. Dig. § 78; Dec. Dig § 62.*]

5. PATENTS (§ 34*)—ANTICIPATION—PRIOR PATENTS.
Where it is sought to show the state of the art by prior patents, nothing can be used except what is disclosed on the face of such patents which cannot be reconstructed in the light of the invention in suit and so used as a part of the prior art.
[Ed. Note.—For other cases, see Patents, Dec. Dig. § 34.*]

6. PATENTS (§ 65*)—ANTICIPATION—ACCIDENTAL FEATURES OF PRIOR STRUCTURES.
The accidental occurrence of an element or feature of a patented combination in prior structures, where its character and function as subsequently used were not recognized, does not constitute an anticipation.
[Ed. Note.—For other cases, see Patents, Cent. Dig. § 80; Dec. Dig. § 65.*]

7. PATENTS (§ 167*)—CONSTRUCTION—ANTICIPATION.
The mere casual reference in the specification of a patent to a given feature will not make it a part of the invention, unless it is relied upon in describing the same.
[Ed. Note.—For other cases, see Patents, Cent. Dig. § 243; Dec. Dig. § 167.*]

8. PATENTS (§ 61*)—ANTICIPATION—EVIDENCE—ACTION OF PATENT OFFICE.
The fact that two applications for patents were pending in the Patent Office and before the same examiner at the same time, and no interference was declared, is evidence that they were not for the same invention, and that one patent does not anticipate the other.
[Ed. Note.—For other cases, see Patents, Cent. Dig. § 77; Dec. Dig. § 61.*]

9. PATENTS (§ 328*)—VALIDITY AND INFRINGEMENT—RESERVOIR FOR STOVES.
The Beckwith patent, No. 787,425, for a reservoir for stoves and ranges, claim 11, is not void for indefiniteness, nor for anticipation, but discloses patentable invention; the combination shown being one of great utility and success. Also, *held* infringed.
[Ed. Note.—For other cases, see Patents, Dec. Dig. § 328.*]

In Equity. Suit by Arthur K. Beckwith against the Malleable Iron Range Company. Decree for complainant.

This is a bill in equity charging infringement of letters patent of the United States numbered 787,425, issued to complainant April 18, 1905, the application for which was made on the 11th day of September, 1903. Prayer for an injunction and accounting.

The answer denies that complainant was the first inventor and discoverer of the improvements described and claimed in complainant's patent; alleges that the said alleged invention in all material points thereof had been anticipated by a large number of patents, references to which are set out. The answer also sets up prior use of the supposed invention in this country for more than two years prior to the complainant's application, and a list of such prior users is set out. For further answer the defendant alleges that said patent discloses no patentable invention; that its several claims are inexact, incomplete, illegal, and void.

The only claim of complainant's patent involved in this litigation is claim No. 11, which reads as follows:

"In a stove or range the combination of the convex and rigid back-plate; the sheet metal reservoir; and means for clamping said reservoir against the convex surface of said plate for the purpose specified."

*For other cases see same topic & § NUMBER in Dec. & Am. Digs. 1907 to date, & Rep'r Indexes

FIG 3A COMPLETE TYPICAL DIGEST OF A LEGAL DECISION

decisions of the Courts, can be applied with great advantage to the publications of the Society, although it would require some modification and adaptation in carrying out the details. The most desirable procedure would apparently be to begin by digesting all papers which are published by the Society from now on, and, in between times, to work backward through the publications until ultimately the Transactions and the Journals would be fully digested.

There are two ways in which the digesting could be done according to the amount of time and expense it was desired to spend upon it. The first way would be to have the syllabus go only so far as to indicate the name or nature of the point being digested, so as merely to tell the searcher in what papers there is any information upon the point. This would make it necessary for the searcher to consult each paper in which the point was treated, but it would save him the trouble of looking at all other papers on the same general subject which might, by any possibility, treat the point, and it would indicate to him the precise page on which the point appeared in those papers in which the point was treated.

The second way in which the points might be digested is to have the syllabi indicate the nature of the point digested, and how the point is treated in the paper. This form of digesting would not only have all of the advantages of the preceding form, but it would often save the engineer from getting out the volume in which the paper appeared and looking at the paper itself, because it would enable him to judge whether or not it is likely to give the precise information he wished.

As an example of the first form of digesting, in which the nature of the point only is indicated, without disclosing how it is treated, the following might be given:

MACHINE ELEMENTS

GEARING

Kind of steel for gears subjected to heavy duty, and details of treatment and machining are given.
Gears for Machine Tool Drives, by John Parker, 1913 Proceedings, p. 785, at p. 787.

As an example of the second form of digesting, in which the nature of the point is stated and also the manner in which the point is treated, the following may be given:

MACHINE ELEMENTS

GEARING

For gears of small proportions, but subjected to very heavy duty, a five per cent nickel-steel has been found excellent. Blanks are preferably drop-forged and given an oil treatment by heating to 1550° F., and quenching in oil; then annealed by reheating to 1350° F. and cooling very slowly before machining. After machining, gears are carbonized by packing in carbonizing material, and heated to 1700° F. in the absence of air for three or four hours. After cooling in the packing, they are then reheated to 1550° F. and quenched in oil, and again reheated to 1380° F. and quenched.
Gears for Machine Tool Drives, by John Parker, 1913 Proceedings, p. 785, at p. 787.

This second form of digesting, while more expensive, might well give the engineer all he wished to know on the point, or, if not, might show him that the information of the paper on the point is along different lines from those on which he was seeking information.

When the digesting is once up to date, the expense of it would be unimportant and by digesting only the principal or generic points of a paper, and not attempting to digest the subordinate or specific points, the expense could be reduced, and the labor of the searcher upon the specific points would be very greatly reduced, because unless a paper contained the generic point, there would be no possibility of its containing the specific point.

It would, of course, be necessary to make the digest or syllabi cards, and also to provide a classification of them so that a searcher could put his hand readily on all the cards relating to the particular point on which he was working. Upon this classification problem, the experience of the United States Patent Office would be of considerable use. The Patent Office has had over 1,100,000 United States patents to classify, so that the Examiners, in making a search to determine whether or not an invention disclosed in an application for a patent is new, can readily find all the United States patents relating to the same subject. Not only this, but the classifi-

cation has been carried out to great sub-division so that when the Examiner is searching for particular details of an invention he may find all the patents which might have such details, separated out into a comparatively small sub-class, and thus reduce his labor to the smallest proportions.

The sub-division of class No. 164 of Cutting and Punching Sheets and Bars, is here reproduced as a typical example of the manner in which the Patent Office classifies all of the patents relating to one particular art (Fig. 4).

CLASS 164.—CUTTING AND PUNCHING SHEETS AND BARS. (XIV.)

(See Definitions of Revised Classes.)

Subclasses.

1. **Buttonholes—**
3. Knives.
2. Machines.
4. Pliers—
5. Modified scissors.
6. Scissors attachments.
11. **Combined machines—**
13. Die cutting and punching.
14. Pivoted knife-carrier.
15. Reciprocating knife-carrier.
16. Roller-cutter and punch.
12. Work-feeding.
17. **Cutting—**
18. Die—
20. Dies—
31. Adjustable-face.
33. Blank-ejecting.
32. Multiple concentric.
30. Spiral-strip-cutting.
19. Machines—
23. Reciprocating cross-head—
24. Shifting dies.
25. Reciprocating plunger—
26. Lever-operated.
27. Screw-operated.
28. Roller-die.
20. Work-feeding—
21. Reciprocating feeder.
22. Roller-feed.
80. Implements—
81. Pliers.
82. Sweep.
83. Traveling—
84. Roller-cutter.
34. Machines—
35. Band-knife.
78. Cutting-tables—
79. Work-clamping.
36. Fixed-cutter—
37. Spiral-strip.
38. Work-feeding—
39. Roller-feed.
40. Oscillating apertured cutters.
41. Pivoted-cutter—
44. Lever-operated—
46. Compound-leverage.
45. Work-clamping.
43. Transverse.
42. Work-feeding.
47. Reciprocating-cutter—
51. Automatic-clamp.
58. Cutters and bed blocks.
53. Draw-cut—
54. Automatic-clamp.
55. Separately-operated clamp.
56. Fluid-operated.
59. Gages.
57. Lever-operated.
50. Notched work.
52. Separately-operated clamp.
48. Work-feeding—
49. Roller-feed.
60. Rotary cutter—
63. Curved platework.
70. Cutters.
64. Notched work.

Cutting—
Machines—
Rotary cutter—
69. Rotary work-mandrel.
65. Slitters and winders.
66. Transverse—
68. Work-feeding—
67. Printing-press attachments.
61. Work-feeding—
62. Reciprocating feeder.
71. Sweep-cutter—
72. Elliptical work.
73. Traveling cutter-carriage—
74. Motor-driven cutter—
75. Reciprocating.
76. Rotary.
77. Roller-knife.
Expanded metal—
6.5. Reciprocating.
6.6. Roller.
7. **Fence-barbs—**
8. Cutters and dies—
9. Roller.
10. Processes.
10.5. **Printer's leads.**
85. **Punching—**
119. Implements—
120. Pivoted handles—
121. Pliers—
122. Turret.
123. Traveling-roller.
86. Machines—
118. Dies and die-holders.
87. Feeding and punching—
88. Reciprocating-feed.
89. Roller-feed.
116. Feed mechanisms—
117. Reciprocating.
90. **Gang—**
91. Lever-operated—
92. Foot.
93. Pattern.
94. Hammer.
95. Hydraulic.
96. Lever-operated—
97. Foot.
98. Printers' rules.
111. Punch-selector—
112. Keyboard-controlled—
113. Electrically-operated.
114. Pattern-controlled—
115. Electrically-operated.
99. Roller—
100. Printing-press attachments.
101. Screw-operated.
102. Shaft-driven—
107. Safety devices.
104. Stop devices—
105. Shaft-clutch.
106. Stroke adjustments.
103. Tilting-frame.
110. Strippers and hold-downs.
109. Tie-band tongue.
108. Tube.
125. Processes.
124. Punches.
106. **Scrap-cutting.**

FIG. 4 TYPICAL PATENT OFFICE CLASSIFICATION OF AN ART

While the Patent Office has carried the sub-division of its classification greatly beyond what would be necessary for this Society, still its work would be very useful in devising a classification for a digest for the Society. The Society would only be interested in a relatively small proportion of the entire two hundred and fifty main classes, but the Patent Office arrangement of main classes (together with the definitions of the classes and sub-classes which it publishes of which Fig. 5 is a portion relating to the class shown in Fig. 4) would serve to sub-divide completely, on broad lines, the entire field of work covered by the Society, without overlapping of the classes.

The larger sub-divisions of the main classes would probably be useful in the Society's classification, although the more minute sub-divisions would probably not be needed.

CLASS 164.—CUTTING AND PUNCHING SHEETS AND BARS.

DEFINITIONS.

Class.

This class embraces machines and processes for cutting, including die cutting and punching sheets, plates, or bars of metal, cloth, rubber, leather, paper, etc.

Machines for splitting and skiving of leather are classified in 69, LEATHER-WORKING.

Machines specially designed for working on boots and shoes, except die-cutting, are in class 12. BOOT AND SHOE MAKING.

Subclasses.

1. BUTTONHOLES. Devices for cutting buttonholes, usually in cloth or leather.
2. BUTTONHOLES, MACHINES. Machines for cutting buttonholes.
3. BUTTONHOLES, KNIVES. Buttonhole cutters having a knife form of cutter.
4. BUTTONHOLES, PLIERS. Buttonhole cutters having a plier form.

Search Classes—

164—CUTTING AND PUNCHING SHEETS AND BARS, subclasses 81, Cutting, Implements, Pliers, and 121, Punching, Implements, Pivoted handles, Pliers.

81—Tools, subclass 187, Pipe and rod cutters, Pivoted, and subclasses thereunder.

5. BUTTONHOLES, PLIERS, MODIFIED SCISSORS. Buttonhole-cutters in which an ordinary pair of scissors is modified to cut the buttonholes.
6. BUTTONHOLES, PLIERS, SCISSORS ATTACHMENTS. Devices adapted to be secured to ordinary scissors to cut the buttonholes.

6.5. EXPANDED METAL, RECIPROCATING. Machines provided with a reciprocating cutter adapted to slit sheet metal and also provided with means for corrugating or for stretching the sheet.

Note.—Machines for forming expanded metallic lath are classified in this subclass. Machines for forming corrugated metallic lath are classified in class 153, METAL-BENDING.

FIG. 5 DEFINITIONS OF CLASSES IN FIG. 4

It would not be necessary that the Society's digest be printed or published, but if a single, hand-written digest were maintained in the Society's rooms, it could be used by every member of the Society either by personal access to it, or by ordering complete copies of all the digest cards on a particular topic or, at least, a list of the volume and page-numbers of such cards.

The work of digesting the current papers might be considerably reduced by asking those members who were willing to do so, to digest their own papers, although it would probably be desirable to have such digests revised by the person whose duty it was to do the digesting in general.

I believe that a single competent man, working under the supervision of a Committee, could digest the current papers and have the bulk of his time for working backward, digesting the Transactions and Journals, so that in the course of two or three years the entire literature of the Society would be digested. Such a man, to be most successful, would need to be not only able to understand the papers he was digesting, but to be capable of generalization, so that he could condense a section of a paper while preserving its true proportion and import.

In the light of many years' experience with the proposed plan of digesting and classifying records, as it has been applied to the records of the profession of the law, I feel confident that it is thoroughly feasible and practicable to apply it to the records of the profession of mechanical engineering, and long experience with the classification of the

Patent Office leads me to believe it would be of much aid in adapting the system to engineering records. The expense to the Society would not need to be burdensome, as one man could accomplish the work within a reasonable time, and such expense would be small compared with the value of the time saved to the members of the Society. The effect upon the publications of the Society would be to make each paper perpetually "current" instead of their now being usually ephemeral. I recommend, therefore, that the Council be asked to appoint a Committee to consider the question.

DISCUSSION

SELBY HAAR expressed the opinion that a digest of the records of the Society would be of less value to engineers than to lawyers. For although it would eliminate most of the labor of acquiring knowledge, it would tend to make one unlikely to remember what he wanted, when he wanted to use this material again. Besides that, the engineer would usually need to get the information much quicker than is necessary in law and patent cases, and would not have time to refer to a digest, which would be too bulky for ready reference.

A. M. COYLE said that he considered the author's idea one of the best suggestions that had been offered to the Society. Much time is wasted in hunting for information, and there is a vast amount of useful material published by the Society, which becomes useless because it is too difficult to find. He suggested that instead of a manuscript digest kept in the Library, there should be a system of cards to be issued to members, at an expense not to exceed $1.00 a year. The slight amount each would pay would very nearly cover the cost of the digest. Once started, the plan would be self-sustaining not only for members, but for a great many other people who would be glad to have the information.

WILLIAM KENT expressed his appreciation of the paper, and said that the need for such a digest as Mr. Prindle proposed was an increasing one. He suggested that there would be a great deal of cross-indexing for each paper. For example, the paper by D. S. Jacobus, Tests at the Detroit Edison Company's Plant, might be placed under the general head of steam boilers, but should also be cross-referenced under the head of labor questions, because there is in it a statement how to pay wages in the boiler room.

THEODORE STEBBINS suggested that the Society bear a part of the expense, and a notice be put in The Journal to find out how many would subscribe for these cards, so that the expense might be borne partly by the Society. He thought that besides the set of cards in the Society rooms, there should also be a set on file in the Library and that manufacturers and others who wanted cards should subscribe and finance the scheme in that way. He believed that the records for the current and the future years should be rather fully compiled, and that for previous years, a shorter method be followed to save expense and expedite the work.

HENRY HESS contributed a written discussion, in which he said that while the indexing and digesting of the material in the Transactions would be useful, the scope would be limited, just as the digest of only one court would be of limited use. An engineering digest to be broadly useful should include the work of the four National Engineering Societies, and probably also the matter contained in the foremost engineering publications. Moreover, the engineer who would fully post himself on any given subject would have to search not only the literature of the United States, but that of the principal foreign countries as well.

The necessity of something of this nature has long been recognized. Partial digests have been published in the United States, in England, in Germany, in France and in Belgium. Probably the most ambitious undertaking of its kind, the Technische Auskunft, until recently issued every month, was a volume covering the entire world's technical literature in five languages. In Belgium, a monthly Revue Technique is published and indexed under the Dewey system. It is thus clear that there exists a very general demand for this work, but it is equally clear that the demand can best be supplied under the auspices of an association that is not primarily intended for profit making. There is little doubt the work could be made self-supporting, in time, once it is thoroughly started and carried to a point where its value can be recognized. Mr. Hess suggested that the Council refer the matter to the Engineering Foundation, through which the scope would at once be extended to cover the four national societies, associated in the Foundation.

A. M. COYLE said that what Mr. Hess suggested would cover such an enormous area, that it would be difficult to reap any results in the near future. Without delaying in any way the general ideas of Mr. Hess, the American Society of Mechanical Engineers could proceed with its own records as a start.

WILLIAM KENT said that he would like to see this undertaken by the Society first, and after it had been systematized, the other societies might get out similar cards. He suggested that a conference committee of representatives of the different societies should get up a scheme of indexing that would meet the needs of all the societies.

SELBY HAAR pointed out the fact that this digesting was not entirely new in the four societies. The American Institute of Electrical Engineers has for some time been presenting with each paper a digest of what it contains. The very complete index of all the Transactions of the Institute, published about a year ago, is so thoroughly cross-referenced that it would serve as a digest. In any intersociety undertaking it would be necessary to reckon with the work already done.

THE AUTHOR said in closing that he believed it would be better to start the plan within the society, and to leave to the Council the matter of passing it on to the Engineering Foundation. Otherwise the idea would be so expanded, that it would be likely to fall from its own weight. In answering Professor Kent's remarks on cross referencing, he said that his idea was not to put on a single card the entire digest of a paper, but only the point or points which would go under one sub-division of the classification. It would be possible to assemble on one card perhaps three or four points from different papers, but only such as would go under one sub-division. In this way cross-referencing is avoided in legal, and could be avoided in engineering digests.

BOSTON SYMPOSIUM ON EMPLOYMENT AND EDUCATION

A Joint Meeting of The American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Boston Society of Civil Engineers was held at Wentworth Institute on the evening of February 26th. A buffet supper was served, after which the new shops and laboratories of the students were inspected. There were over 200 present, and at eight o'clock the audience assembled to listen to a series of addresses, an account of which is given below.

At a joint meeting in Boston held on the evening of February 26th at Wentworth Institute, four addresses were given on subjects relating to employment and education. These were: The Responsibility of the Manufacturer for Training of Foremen and Skilled Workmen by Mr. Walter C. Fish, manager Lynn Works, General Electric Company; The Employer's Side of the Problems of Irregular Employment by Mr. Henry S. Dennison, treasurer, Dennison Manufacturing Company; Coöperation between Employers and the Schools by Mr. William B. Hunter, director of Fitchburg Industrial Schools; and The Economic Relation between the Supply of Skilled and Intelligent Workmen and Unemployment of the Masses by Prof. Thomas N. Carver, of Harvard University.

The meeting was opened by Principal Arthur L. Williston of Wentworth Institute who said in welcoming the guests that the endeavor of the Institute had not been to reach up into the higher fields of technical education. It was a trade school for the training of the workmen, foremen and master mechanics of industrial plants; and although those who were present were engineers he felt that they and the Institute had a vast field in common.

ADDRESS BY WALTER C. FISH

Mr. Fish said that he wanted to enlarge his subject at least temporarily so that it would become "The Responsibility of the Community for the Training of Foremen and Skilled Workmen." The manufacturer is helpless if he does not get the coöperation of the community which has such vital interests in the matter and if the manufacturer does not get a decent product from the community his task is correspondingly accentuated. The manufacturer is largely dependent on the educators of the community and the future of this country depends ultimately on education and average intelligence. Mr. Fish also expressed the belief that the early school training of the young man destined to become an artisan should be as far as possible along lines leading to a good general education, and the workshops of the country should take more active interest and more responsibility in supplementing this education. To emphasize this conviction the speaker read an extract from Huxley's essay on Technical Education written in 1877. While some might say that men of that time were likely to be behind the times from the standpoint of today he thought it was fair to say that Mr. Huxley was many, many years ahead of his time. Mr. Huxley said:

> The workshop is the only real school for a handicraft. The education which precedes that of the workshop should be entirely devoted to the strengthening of the body, the elevation of the moral faculties, and the cultivation of the intelligence; and especially to the imbuing the mind with a broad and clear view of the laws of that natural world with the components of which the handicraftsman will have to deal. And the earlier the period of life at which the handicraftsman has to enter into actual practice of his craft, the more important is it that he should devote the precious hours of preliminary education to things of the mind which have no direct and immediate bearing on this branch of industry though they lie at the foundation of all realities.

The speaker, continuing, said that for the last few years he had had more or less control over a large body of men and had constantly been in contact with their work. The practical results of his observation were precisely those suggested by the words of Mr. Huxley. Regardless of whether the young man comes from the grammar school, the high school or a school like Wentworth Institute, his education must be finished in the workshop if he is to be a successful artisan. The manufacturers must round off his education because it is only in the shop that he can obtain certain things which he must have if he is to be successful. Manufacturers must become educators and must more and more attempt the performance of those things which perhaps would have subjected them to ridicule if they had been attempted fifteen or twenty years ago. He would prefer to have a young man come to him who really understood the actual causes of the American Revolution or the Rebellion or the French Revolution than one who perhaps had been taught elementary molding or carpentry. The former was likely to be broader and better and more successful.

This is not an attack on vocational schools; the main thing is to keep the young man at school and certainly in this respect the vocational schools of this country are serving a most useful purpose. They attract and educate many who would leave the public schools at too early an age but who will not leave vocational schools.

Young people leave the public schools at fourteen or fifteen years of age because the public schools of today are not interesting. Many teachers who are thoroughly conscientious and hard-working have not been taught to make grammar and the other so-called dull studies interesting. These things are up to the community and not up to the manufacturer who is not obtaining any too good a product for his workshop. It must be remembered that the manufacturer has to deal with people of whom a large percentage are common people, suited, when they enter his establishment, to do common things. It seems fair to say that not more than one or two at the most out of every ten who enter industrial establishments have any reason to be considered subjects for marked advancement or for educational work on the part of the manufacturer. What shall be done with these one or two out of ten, or it is better still to say five or six out of a hundred? The best answer at the present time appears to be to organize freely and maintain apprenticeship systems. If a young man is to be started in a career he must be guided, by which is meant that he must learn practical things by system. We should make apprenticeships more flexible so that our workshop students will not all be treated in the same way. Better recognition

must be had of the experience and education of each individual to the end that when the boy reaches certain set results, he will pass out of the apprenticeship system into his life work.

The fact was emphasized that the foremen are found, not made. The principal qualification of a foreman is in his own proper individuality which depends in large part on extremely early influences and perhaps more or less upon heredity. The first thing any successful foreman has to learn is the ability to put himself in the other fellow's position. He must not only be a man of good disposition, but one of breadth and understanding.

No one can take ten graduates from any school and teach them to be men of good disposition, possessing the innate characteristics essential for good leadership. If they are not born with these faculties the only thing will be to find others who are.

What is a foreman? In different corners of the shop he must possess all sorts of different qualifications. He may be put into a department where he controls 80 per cent material and 20 per cent labor; he may be placed in a department where he controls 80 per cent labor and 20 per cent material. In this latter department there may be no machinery at all, while in the former department he may have charge of the most complicated machinery. A great deal is said nowadays about efficiency of organization and the importance of the question cannot be overstated. Most manufacturers, unfortunately, find they still must organize with reference to available material, and the qualifications of disposition and ability to control men are often missing in those candidates for foremanship who possess marked abilities in other directions,—technical and mechanical, for instance. There are no definite specifications, and the successful manufacturer will seek in each case for the man who, though helped and trained by his school and apprenticeship life, will have largely made himself suited for the position.

ADDRESS BY WILLIAM B. HUNTER

In considering the subject of Coöperation between Employers and the Schools, William B. Hunter said that we hear a great deal of criticism by employers of the product that the schools are turning into their shops, while the boys on their part do not know what trade or business they are fitted for on leaving the grammar or high school.

This is one of the phases of the situation particularly recognized by the coöperative system carried on at Fitchburg, Mass. It was organized because a business man saw that it was a business way of furnishing boys to business houses.

After the boy has spent one year in the high school, he goes to work in a shop as an apprentice. He spends one week in the shop and the next week in the school. He is registered in the shop one whole week and the next week when he goes back to school his place is taken in the shop by another boy. In that way there is no idle machinery and no idle school; machines always going—schools always going.

It is real business for the boy in the shop, unlike most school shops where everything is ideal. The manufacturer takes an intelligent interest in the boy and if the boy is not going right, he sees it. He does not have to take it for granted that the school is teaching this or that; he sees results. The boy is in the shop to work and he is paid by the hour. It is a commercial proposition, not philanthropic.

It is firmly believed that the public schools should take care of this plan of education. The employer is already taxed for public education and the public schools are responsible for the training of our young people. Public school training is the best for the boy. Why should the employer have to duplicate the public school system by putting in a school in his own plant? Instead of erecting another school building the capacity of the present school building is doubled by this system since only one-half of the boys are in school at one time. Then as to the manufacturer who is going to take care of the boys afterward, why should he not be willing to help make better workmen of them? It is a better plan for the manufacturer, and it is better for the boy.

How about loyalty? When a boy starts an apprenticeship course and grows up he certainly will be loyal. If he serves his time with Brown & Sharpe, for instance, later when he goes out he will talk for Brown & Sharpe and the things he saw there. We have found this to be true.

The idea of giving wages to the boys makes it possible for them to continue in the high school; otherwise he might have to drop out before finishing his course. He cannot afford to go to the trade school. The rate paid to the boys the first year is 10 cents an hour—not much but it helps considerably. In a good many cases this is the means of keeping the boy at school. He gets a little more the second year and a little more still the third year.

The average boy after leaving high school is trying his hand at this and at that. He does not know what he is fitted for. With us, if the boy sticks to his course to the finish he has a definite trade with which he can go out and earn his living, not alone in the shop where he spent alternate weeks while at school, but in any other shop.

It has been asked why boys leave the high school. When a boy gets to be about fourteen he wants to earn something and not be obliged to have to ask his father for a quarter now and then. Our coöperative system satisfies the boy's desire to earn money, which makes him willing to remain at school. This is better than having the boy drop his school work and go out to take the first job he can get regardless of what it is, so long as it offers wages.

Then, after graduation he is assured of a job. He is actually a journeyman when he gets through and can go into another city and earn $3.00 a day. He not only has his shop experience, but while in school has been studying shop problems. He has become acquainted with the problems of the workmen and is more serious and earnest than the high school boys who often remain in school simply as an excuse for having a good time. He has learned that a working man is just as good as anybody else, that work is honorable, and that one who gets his hands dirty by work is just as good as one who does not. This is not always the attitude of the young men coming from our high schools. Thus we are teaching the boys democracy and they do not fear that they will be looked down upon for going to work in the shops after graduation.

A good many of the manufacturers visit the schools and help solve some of its problems. We teach in Fitchburg the metal trades and allied trades: machine-work, pattern-making, saw-making, drafting, iron-molding, tin-fitting, piping, printing, textile and office work, and it is planned later to take up the building trades and even farming. The manufacturer meets with the director each month and discusses the

various problems as they come up. He tells what we ought to do to help him and we frequently go around to the shop and see for ourselves.

A number of leading firms in Fitchburg are coöperating with this school. Most of the larger machine shops and textile plants have been willing to take some of our boys every year which shows the plan to be a success. This idea is not confined to Fitchburg alone. There are similar undertakings at Providence, R. I., Springfield, Vt., Chicago, Ill., York, Pa., Lansing, Mich. and other places. It does not cost anything to start the system; no shops or machinery have to be put in the school, but instead, the live commercial going shops of the city may be used. Our cities are all poor. By our coöperative method, they are getting dividends on education. Our boys have made over $100,000.00 which has gone into the pockets of the citizens. It is giving the workman an education so that he will make a better workman and be fitted in many cases for a future foreman.

ADDRESS BY PROF. THOMAS N. CARVER

Professor Carver spoke on The Economic Relation Between the Supply of Skilled and Intelligent Workmen and Unemployment of the Masses. He said that one of the elementary commonplaces of economics is the observation that all men do in industry is to move things about from one place to another. Back of this process of moving things there is at least a purpose, which, it may be fairly stated, is to get things together in the right proportion.

Whether one is a chemist mixing a compound in a laboratory or an engineer digging a swamp, irrigating a dry plain, or erecting a building, he is simply trying to get things together in the right proportion. All this requires human labor, and today the distribution of human talent has more to do with the bad distribution of wealth than any other single factor. In comparison with this, other things are trivial—getting human talents of various kinds combined in the right proportion.

Now suppose that material things are in the wrong proportion for common use, as, for example, the water in the swamp just referred to, there being too much water in proportion to the soil. While it may be perfectly good water, it is not worth much there. Only a certain supply of water is necessary to make plants grow. It is the bad proportion between water and soil which makes water so cheap.

Again, if one is trying to make gunpowder which is composed of a mixture of saltpeter, sulphur and charcoal, he may have more charcoal than he can use but not a sufficient supply of one of the necessary materials. Charcoal must therefore be cheap. This illustrates just the problem that is met with in unemployment. One can try a laboratory experiment and put the proposition to the acid test. Let one disguise himself as an unskilled workman and go out looking for an employer. Then go out as an employer looking for unskilled workmen and see under which condition there is the greater difficulty. The situation is exactly the same as in the case of gunpowder in our illustration—no matter how great the demand for gunpowder one cannot use the charcoal. The charcoal is out of employment because one cannot find enough saltpeter to mix with it.

It would seem as though since there is a demand for commodities, there should also be a demand for labor. The demand for commodities in itself will not and does not give employment unless there is something else. No matter how great the demand for commodities nor how great the supply of manual labor, unless there is the employing talent in between, you cannot use that human labor. This is a bad distribution of human talent; too much of one kind and not enough of another kind.

There is an idea abroad that there must be available means of employment for everybody. Since labor produces all the wealth, there must be a demand for labor. But here is where the first principle of economics should be applied. There must be some other things besides unskilled labor, if wealth is desired. The difficulty is that there is not a sufficient supply of skilled labor to do the skilled part while the others do the unskilled part; splendid charcoal but not enough saltpeter.

Now if it were possible by some miracle to transform the charcoal into saltpeter it would, of course, be an immense help to the situation. By transforming a little of the charcoal into saltpeter one could then use the balance of charcoal. Similarly, if we could only transform one kind of labor into another, our problem would be solved. The chief value of education of any kind is that it tends to redistribute human talent and train men for positions where men are scarce. That is the miracle which will transform the charcoal into saltpeter. Put these things together in the right proportion and if we can do this thoroughly there will no longer be unemployment.

This trade training is excellent as far as it goes, but there is danger that it may stop too soon. Our greatest need is not for skilled laborers. Of course we need them, but employers are what we want. What we ought to do is to try to bring about conditions where there will be two employers where there now is one. Make more employment for labor and wages will rise.

There are different kinds of skilled labor which have to be combined: the skilled labor of the manager and of the investor, the man who knows how to start an enterprise. The man most needed is the man who can see opportunity for a new enterprise, and not only see it but make it go and produce a favorable balance sheet,—such a man is even more important than he who can make two blades of grass grow where only one grew before.

There is no such thing as eliminating poverty or unemployment until we make employment enough to absorb all the men who are now looking for jobs, and a little more,—until we can make two jobs where there is but one man, so that the employer has a hard time finding labor. Employment must be more plentiful than labor. At the present time perhaps ten men will apply for one job. Poverty will be eliminated when conditions are reversed and ten employers will be seeking the services of the same man.

It just depends upon how much we really want to get rid of unemployment and of poverty. If we want to enough we can do it. It will mean a harder time securing workers if we have to compete for every man. Chasing after him will mean a little more inconvenience, but wages will be better for the workmen.

In addition to increasing the number of employers, we can do something toward thinning out the number of the unskilled. Education is itself thinning out these numbers. Every time a man is trained out of the unskilled class there is one man less there, unless more come in from the out-

side, and a little restriction at that point would be beneficial. Some restriction of the inflow of labor from the outside would go a long way toward thinning out the ranks of the unskilled. After a while when the employer advertised for a workman, there would not be anybody after the job.

This point is so absolutely clear and simple that I do not take anybody seriously who professes to have any interest in the labor problem and yet does not want to see immigration restricted. It sounds well to say that we must keep our doors open to the poor and oppressed of the world, but I am inclined to think that the appeal to the pocketbook is rather stronger than the appeal to sympathy.

About equality: If one man can do twice as much as another, he is worth twice as much. As between bricklayers and bank presidents there can be equality by making it as hard to find a bricklayer as it is to find a bank president and their wages will be the same. All this comes down to the question of supply and demand.

To go back to the saltpeter argument. In the condition where there is more charcoal than will combine with the smaller supply of saltpeter existing, one will be cheap and the other will be dear. There is nothing unjust about it. The price of one depends upon the existing supply of the other when they both have to be combined to make the gunpowder. The only way to equalize the value is to produce more of the saltpeter or shorten the supply of charcoal. It is a very plain question of supply and demand.

On the dry plain, water is necessary for the production of plant life. Water should be worth a good deal there, but it is not worth so much in the swamp where there is too much of it. If we could bring the water from the swamp to the dry plain, the ideal condition would be reached. In the same way labor is more productive and profitable where there is opportunity to use it. When one kind of labor is as much needed as another there will be equality.

ADDRESS BY HENRY S. DENNISON

In speaking of Irregular Employment, Mr. Dennison said in part, there are three classes into which we must divide irregular employment in order to see it at all clearly. One has to do with the long cyclic changes of business prosperity and depression; another with business changes due to the season of the year; and the third, with the rate of labor turnover in mills and factories,—that is, the frequency of hiring and firing.

Let us consider some of the waste which is caused by irregular employment. Mr. M. W. Alexander of the General Electric Company has worked out figures showing estimates ranging from \$39 to \$150 as the cost of each new employee, and when one considers the amount of spoiled work, the amount lost on overhead from short product, the cost of training the new man, the cost of hiring, etc., \$30 is a pretty conservative estimate of the loss caused by hiring a new employee.

Another loss which comes from irregular employment is due to the slackening of speed during the dull seasons and the difficulty of getting back speed when times become better. Even where the employees are on piece rate, they will take all the time they like in such off seasons because there is only a limited amount of work for them and after such periods, it takes a long time for many people to get back into the stride again. Then there is the opposite extreme of overtime at the opposite stage of the season. The factory that can run with a given crew, that gets more and more into its stride and more and more productive, is a lucky shop.

In the building trades where the men are able to find employment only at certain times during the year, they must have high rates of wages for the time they do work to make up for the periods when they are without work. In many cases a long period of unemployment causes permanent injury to the efficiency of the workman.

Again, in connection with shifting employment is the lack of loyalty. Loyalty cannot be developed in the employee who is jumping about from shop to shop.

So much for the cost of irregular employment. What can we say as to the causes and possible chances for improvement? In connection with the cycles of business depression and prosperity, one cause of our difficulty is our complete lack of information about real business conditions at any given date. Many things ought to be known about the stock on hand, about the actual volume of trade, etc. If we could see more clearly where we were at any stage of the game, we could provide more wisely and provision against future difficulties would do more than anything else to prevent those difficulties from coming. If we have gone along in a period of prosperity and signs indicate that sooner or later we shall have a period of depression and we hedge a little for it, the general results will be more wholesome; for while we shall not have so much prosperity for the time being in consequence, neither shall we have so much depression at a later period.

For the seasonal unemployment the causes all finally rest upon weather conditions which affect building trades, the handling of perishable food-stuffs, and indirectly the styles of clothing. One influence that may work toward the betterment of seasonal irregularities is the closer relation between the manufacturing and the selling ends. This we have found, ourselves, to be extremely valuable. Letting both of these departments run without intimate connection caused very considerable difficulties, whereas, when we brought them together and made each serve the other we found large improvements in getting orders out earlier for delivery, anticipation of orders wherever possible, etc.

The weather conditions which affect the building trades to such a large extent presents a technical problem extraordinarily difficult. During some months the contractors do not keep more than 5 per cent of their men and the other 95 per cent are discharged. And even though some of these men—bricklayers, carpenters, etc.—do receive \$5.00 per day while they work, this often means only \$600 or \$700 a year as their total income. Every effort possible must be made to regularize these trades.

The effect of weather conditions in other trades, such as in the candy trade, for instance, has been considerably helped by the refrigerating process; and other technical means can be found to avoid these other difficulties if we are only persistent enough about it.

The irregularity of employment which results from a rapid labor turn-over is a very serious loss to employers, which is very little appreciated. Mr. Alexander found in a group of factories which employed 38,700 employees at the beginning of the year 1912, and 46,800 at the end of the year, that they had hired 44,365 people, indicating that over 36,000 people had dropped out of employment during the

year. Allowing for all the inevitable causes of withdrawal, such as death, sickness, etc., he finds in these industries over 22,000 people engaged above the seemingly necessary requirements. This means to these industries a loss of at least $750,000 a year. In one employing 11,000 people at the beginning of the year, he found that 17,000 had been hired through the year with practically no permanent increase in the crew. And in all the labor turn-over exceeds 50 per cent.

The causes are many and vary somewhat with each factory. They can probably be studied best and most readily corrected through the establishment of a very efficient employment department.

In all these three classes of irregular employment the employer has the largest opportunity to improve conditions and has also the largest amount at stake. Here is a preventable waste, costly to employer and employee alike, in which any improvement will be of financial benefit, will be a help to our country in competition with other nations, and will be a social service.

WENTWORTH INSTITUTE

Wentworth Institute, which acted as host of the evening, was opened three and a half years ago, founded by Aricoh Wentworth, a marble manufacturer of Boston, who bequeathed in his will $3,500,000 for the purpose.

The institute aims to train workmen of the most competent and expert type, foremen and master mechanics. The shops and laboratories, which were inspected at the time of the meeting, are admirably adapted to the special purposes of instruction for which they are planned and their equipment is most complete.

During the short time that the school has been in existence it has grown rapidly and now has nearly 1300 pupils enrolled in its day and evening classes and additional buildings are soon to be erected. It has already given instruction to 3820 students and granted certificates of graduation to over 875 persons who have completed its courses.

The instruction which is offered is of two grades: first, short one-year courses for young men who wish with experience to become high grade mechanics; and second, longer courses for those who have already had practical experience and who wish to become foremen, master mechanics, or superintendents. A wide variety of courses is offered and the aim is to reproduce actual commercial conditions in the shops and laboratories of the school and to work out new courses of applied science as required for the various trades or branches of industry to supplement and go parallel with the practical instruction. This enables the student to understand the technical features of his trade and the fundamental principles of science upon which the trade is based.

SUBMARINES

BY G. E. FURBUSH, SYRACUSE, N. Y.

Student-Member

At a meeting of the Syracuse University Student Branch of the Society held February 12, 1915, an interesting illustrated address was presented on the subject of the modern submarine boat, by Grant E. Furbush, secretary of the Syracuse Student Branch, which proved of interest in view of the active part that has been taken by this form of water craft in the present European war. The author traced the history of submarine boats from the crude efforts of Symons in 1747 up to the present time, and gave detailed information concerning modern practices in this country and abroad. His conclusions, drawn from a careful study of present developments, are of interest, and are here given.

From the mechanical point of view, the submarine is still in a transitory state. Until it is made more powerful, given a higher speed, and has a much wider radius of action, its success must be limited, even in attacking vessels in harbors, particularly in the presence of the latest system of submarine defense. All of these qualities call for increased dimensions, which increase their cost and reduce their handiness, especially in harbors and comparatively shallow waters.

Every increase in the size of a submarine also adds to its visibility when running awash, and increases the time and distance required for disappearing if the vessel has to dive. The difficulty in diving at a steep angle has reference to the electric storage batteries and to other vessels containing liquids where alterations in the level introduce disturbing influences. The acuteness of the angle of dive, also intensifies the difficulty of subsequently bringing the vessel to an even keel, and increases the danger of the vessel striking the bottom, a danger which has involved the loss of at least two submarine boats of comparatively small size. Greater depth of water is required for such operations, so that only small vessels can be used in attacking ships in harbors.

Because of the many variants and the demand for such careful research, slow progress is being made, but the evolution of design can not be hastened. What is demanded on the part of naval authorities is to move with as much rapidity toward improvement as is consistent with the insurance of reliability in each vessel built, and at the same time to maintain as much secrecy as possible.

Thus, from all that has been done the past few months, it is found that the menace of the submarine is really serious. The trouble with it is that it is altogether too small and too slow for deep sea cruising and for the fighting of deep sea battles. When it has reached a displacement of 3,000 tons and can steam at destroyer speed, the type will realize its unquestionable latent destructive power. Then the battleship will have to look to its laurels.

FOREIGN REVIEW AND REVIEW OF THE PROCEEDINGS OF ENGINEERING SOCIETIES

ENGINEERING SURVEY

Every day shows more and more that in engineering nothing should be taken for granted. When first internal combustion engines were designed, the speed of water flowing through the engine jacket was determined off-hand, simply by making the pump as small as could be without alterations, just because the engine ran after a fashion with an efficiency satisfactory for practical purposes. In a paper before the Cleveland Engineering Society, J. B. Merriam shows that the temperature of the water in the jacket has been limited because of secondary phenomena (the formation of bubbles of steam on the walls of the jacket and consequent spheroidal action due to the limited speed of the water). Experiments and then design of machinery of commercial sizes have shown that if the speed of water through the jacket be made approximately ten times as high as usual, the temperature of the water in the jacket can be raised from around 150 deg. to about 250 deg. fahr. without injurious effects, and thus an interesting way of recovery of heat losses can be devised.

In the Foreign Review Section, the first article is an abstract of an investigation on the action of an air jet on the surrounding air, where the methods of tests are described and velocity, volume and energy curves given. The data obtained in this investigation are of considerable interest for air jet machinery and, to a certain extent, to fan manufacturers.

In the next article is discussed a method of electrically determining the efficiency of large water turbines, describing both the mechanical and the electrical ends of the apparatus and methods used. Both cases of separate and self-excitation are covered and the limit of errors discussed.

Henry Lossier investigates the subject of lateral flexure of hollow pieces and develops new rules for the calculation of stresses in structures consisting of two parallel members united at regular intervals by cross-pieces. He gives a formula which he compares with the old Euler formula and the more modern Timoshenko formula, and shows that his formula agrees fairly closely with the latter.

Prof. J. Fischer Hinnen discusses the question of axial loads on radially loaded ball bearings and shows how a play in the bearing brings about very serious additional pressures on the bearing. He also calls attention to the pitting to which shafts on which ball bearings are running are often subject, and ascribes it to electrolytic action indirectly due to the fact that the belt pulley, or equivalent member, is sitting too tightly on the shaft.

Data on evaporation tests with pressed peat and peat coke as values are reported in an abstract from a German publication. Also from a German publication is taken an abstract of tests on the mechanical properties of teak wood.

From the Memoirs of the College of Engineering of the Kyushu Imperial University at Tukuoka, written in German, is taken the abstract of an investigation on the bending elasticity of cast iron, of considerable interest because of the lack of reliable information available on the behavior of cast iron under either tension or bending.

A paper by H. C. Richardson, on hulls for aeroplanes brings us into a comparatively new field of research. The author indicates the essential points of difference between aeroplane hulls and what he calls "boats working in ordinary displacement conditions." The subject of the action of suction on a boat travelling through, and perhaps out of water at high speed has been investigated thoroughly and important conclusions as to the water resistances arrived at. It appears further that a form of hull has been devised for the navy, having decided advantages over those already in use, so far as resistance on the surface and in the air is concerned.

The subject of motor cylinder lubrication is discussed by G. S. Bryan, U. S. N., in a paper before the American Society of Naval Engineers. Among other things, the writer shows that what is generally known as carbon deposits in the cylinders, does not as a rule essentially consist of carbon. He shows further that the flash point of lubricating oil, while important, does not affect the possibility of the oil adhering to the cylinder walls to the extent often assumed.

Two papers of undoubted value are printed in the journal of the American Society of Refrigerating Engineers, by H. C. Dickinson and N. S. Osborne, of the Bureau of Standards at Washington, D. C. One concerning an aneroid calorimeter, in which copper acts as a calorimetric medium for the transmission and distribution of heat, such calorimeter having several important advantages over the usual stirred water apparatus. The other paper contains data of painstaking investigation of the specific heat of ice, especially near its melting point as well as corrected values for the heat of fusion.

J. Irving Lyle, in a paper on air conditioning (Engineers Club of Philadelphia) illustrates the wide possibilities of applying the control of temperature in industrial plants (bakeries, candy factories, printing establishments, etc.) and the great hygienic benefits which can be secured by it.

A series of tests made to determine the type of coating best suited for the protection of metal imbedded in concrete against the action of electrolysis, as well as the bond between concrete and painted metal are described by Henry A. Gardner, (Franklin Institute) and among other things, the author describes a method of increasing the bonding between the metal and cement by applying to the painted surface while still tacky, sharp particles of fine clean white sand, thus forming a rough surface resembling coarse sand paper.

The interesting subject of the production of oils from peat is treated by Dr. F. Mollwo Perkin (Institution of Petroleum Technologists). While the author is by no means sanguine as to the commercial possibilities of such a production, he does not consider the difficulties in its way insurmountable.

The calculation of centrifugal stresses in turbine rotors forms the subject of a paper by William Kerr, before the Scientific Society of the Royal Technical College, Glasgow. Only the parts concerning solid shaft rotors and hollow shaft rotors are abstracted in the present issue. The second

part of the paper will be abstracted in an early issue of The Journal.

The timely subject of the high speed, high efficiency eight cylinder V-Type engine is discussed by D. McCall White, who is responsible for one of the earlier American automobile engines of this type, before the Society of Automobile Engineers. As compared with the former four cylinder engine, the eight is about equal in length, is only wider by 2 in., weighs from 50 to 60 lb. less, uses a short 4-throw crankshaft and is expected to outlast considerably even an equally well designed and made six.

Interesting tests on high speed steel drills are reported in a paper on High Speed Steels, by Fred C. A. H. Lantsberry (West of Scotland Iron and Steel Institute). Among other things, he found that the efficiency of steels as drills increased to maximum when the content of tungsten rose to 14 per cent and then fell off with further increases in tungsten. Vanadium in small quantities proved to be useful, but steel containing one per cent of vanadium above the quantity eliminated in manufacture, was found to be of absolutely no use for drills.

FOREIGN REVIEW

Air Machinery

ACTION OF AN AIR JET ON THE SURROUNDING AIR

The article is an abstract of a university thesis based on experiments carried out in the mechanical laboratory of the Technical High School in Karlsruhe, and proposes to investigate the loss of concurrent motion of surrounding air produced by a jet of air flowing through a nozzle.

When a jet of air discharges from the nozzle of a blower into the free atmosphere, a part of its energy of flow is transferred to the surrounding air, the friction between the various layers of air acting as a medium of transmission. What the author investigates is

a The shape which the stream assumes after its discharge from the nozzle.

b The exchange of energy between the active nozzle stream (core stream) and the passive stream of the surrounding air carried away by the active stream (jacket stream).

The article describes in detail the experimental installation and method of tests and then proceeds to the discussion of the results obtained. The velocity curves, which he denotes as *c-r* (compare Fig. A), where *c* is the velocity of air and *r* is the radial distance of the point of measurement from the axis of the air jet. Such *c-r* curves as have been obtained indicate a rapid decrease of the velocity of jet with the increase of the distance from the nozzle. Immediately at the exit the velocity curve (1 in Fig. A) is practically a horizontal line, that is, in all points of this cross-section the velocity of air is equal. In the next cross-section investigated (x = 20 cm.) this uniformity of distribution obtains only within a certain area, the diameter of which is equal approximately to one-half the diameter of the nozzle, and the air lines on the outer edge of the jet and in its neighborhood have already lost a considerable amount of their velocity. The next curve has no longer any straight section at all.

From the *c-r* curves, the author develops the volume curves by means of the following process. He assumes that the cross-section of the nozzle is a circle and that at each cross-section at points of equal distance, *r*, from the axis of the jet, the velocity of air *c* is equal; then for an infinitely thin ring of thickness *dr* the volume of air flowing through it per second is expressed by $dV = 2\pi rcdr$, and, therefore, the volume of air flowing per second within a circle of radius *r* is $V = 2\pi \int_{r=o}^{r=r} crdr$. This integral can be solved graphically by means of the *c-r* curves found experimentally; it is, however, not the velocity curve itself but rather the curve derived from it, *cr-r*, that has to be integrated.

The product *cr* can likewise be found graphically, but it is more convenient to determine it by calculation, (the author gives a special table to facilitate this), and then plot it graphically over *r* as abscissae. The curves of integration obtained from the *cr-r* curves (Fig. C) then give for each cross-section a definite volume corresponding to each value of *r*, this volume indicating how much air flows per unit of time through a circle corresponding to the given *r*, while the terminal point of the curve, by its ordinates, indicates what total volume of air per second passes through the cross-section of the jet. The graphs in Fig. B show that with the increase of the distance from the nozzle, the terminal point of the crowd of curves which start originally like an *S*, gradually diverges in a diagonal direction, always farther and farther away from the zero point, showing thereby that as the distance from the nozzle increases the radius of the entire jet of air, as well as its volume, increase also. If the radii were plotted as ordinates over the *x*'s of the axis of the nozzle (there corresponds to each curve and value, a definite distance of cross-section) the *r-x* would indicate the extreme meridian line of the jet.

It would be of still greater interest to plot on the same system of coördinates those values of *r* which correspond in the various sections of the jet to equal V. The plotting of such values on the *r-x* system gives a nearly exactly straight line. It appears, therefore, that the active core stream expands conically. By this method of handling the volume curves, the author creates a clear conception of the location of meridian lines limiting the passive jacket stream. From this, he passes to the determination of the amounts of energy contained in the various parts of the jet.

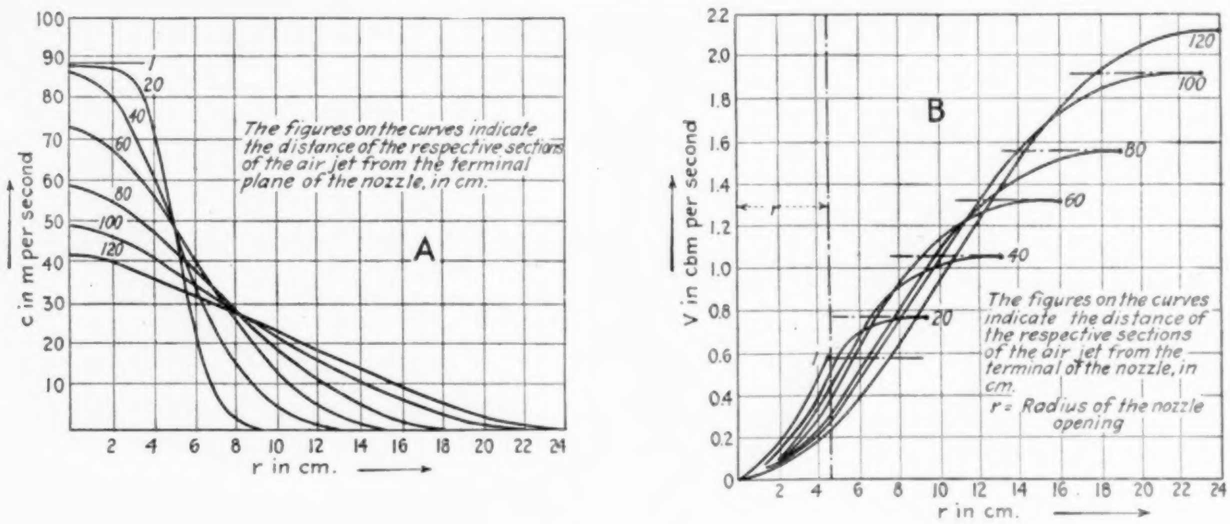
The transmission of energy between various layers of air at different velocities may be also determined graphically from the velocity curves found above. The kinetic energy carried by air volume dV, passing per second through an annular area of thickness *dr* is

$$dE = \frac{c^2}{2}\frac{\gamma}{g}\,dV = \frac{\gamma}{g}\,2\pi rc\,\frac{c^2}{2}\,dr.$$

The latter because $dV = 2\pi rcdr$. Hence the energy of the volume of air which flows through a circular cross-section of the radius r_k is

$$E = \pi\,\frac{\gamma}{g}\int_{r=o}^{r=r_k} c^3 rdr.$$

By r_k in each cross-section under investigation is understood that value of *r* which is found by the process described in the preceding paragraph for the gradual increase in the friction of the jet of radius of the active core stream. Hence, the integral gives the amount of energy contained in the respective sections of the core stream. If it should be integrated now up to the value of *r*, corresponding to the velocity $c = 0$ or



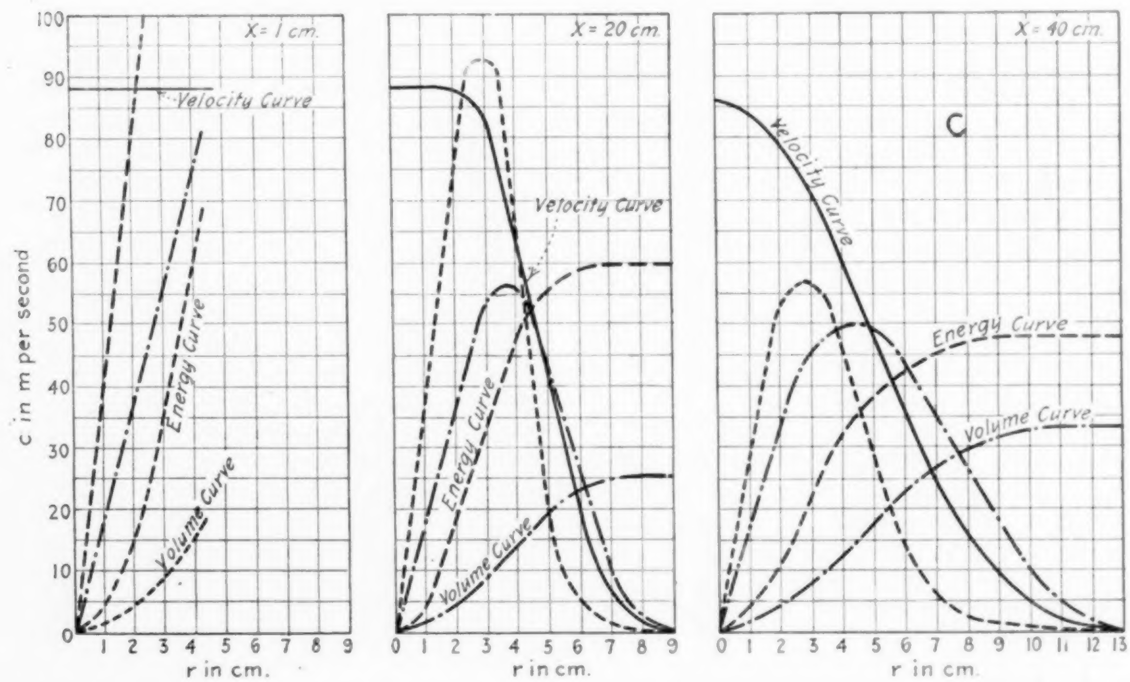
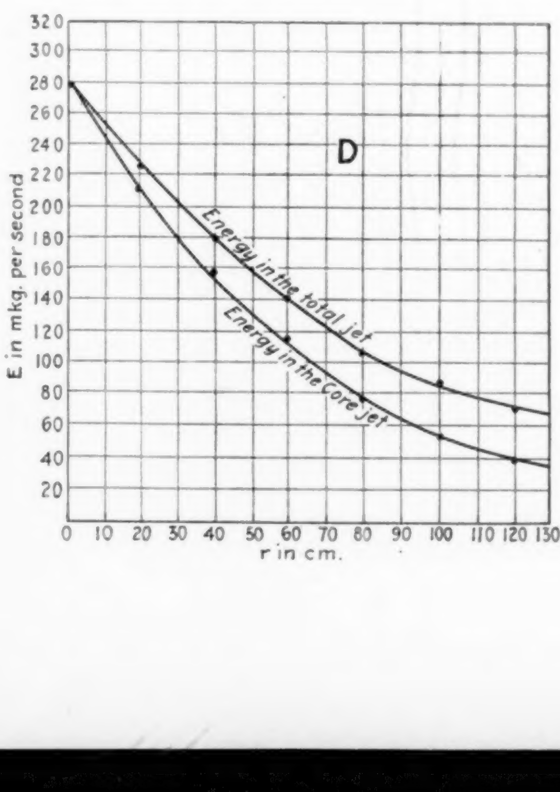


Fig. 1 Action of Air Jet on the Surrounding Air

A. Velocity curves $(c-r)$; B. Curves of volume as function of distance from nozzle $(V-r)$; C. Volume curves and curves of integration of the $cr-r$ curves; D. Energy curves for total jet and core jet



up to the limit of the jet, we obtain the total energy of the moving stream of air. The difference between the two integral values, that is, the difference between the energy of the total jet and that of the core stream, represents the energy in the jacket stream.

For purposes of graphical solution, the numerical values of c^3r are calculated and plotted as ordinates over the values of r as abscissae; then an integral curve is constructed for the c^3r-r curves thus obtained. We obtain here again S-shaped curved lines which start, like the volume curves, from the region of coördinates. Contrary to those latter, however, the terminal point of the distance from the nozzle approaches nearer and nearer to the r axis, while in the course of flow the volume increases as the energy contained in it constantly

decreases, more and more. Now if these values of energy be plotted over x as abscissae, each on the E-r curves belonging to the limiting value of r_k and of r, which corresponds to the velocity $c = 0$, we obtain two series of points of which one represents the variation of energy in the active core stream and the other in the total stream (Fig. D). At the opening of the nozzle, in both of them, the decrease of energy is maximum, but with the increase of distance from the nozzle, the amount representing the decrease of energy, either in the core or the total stream, becomes smaller and smaller as indicated by the decreasing inclination of the curves. Finally, the value of energy must sink to zero, which happens for both curves at the same value of x. Experimentally the investigation could not be carried to this point.

The energy curves of Fig. D, obtained from the above experiments, indicate in particular that the energy in both cases falls off very rapidly and that the larger part of the energy contained in the jet is not carried away by the latter but is wasted on the way through friction and eddy formation. Even at a distance from the nozzle as little as $x = 60$ cm. the amount of energy contained in the inner stream was only one-half of the energy which the stream had as it left the nozzle. This loss of kinetic energy ought to be compensated for by an increase in some other form of energy; in this case, the increase in temperature. This could not be established experimentally, however, both because, as the author shows by calculation, such an increase in temperature would be very low and especially because this measurement in the rapidly flowing air is extremely difficult.

From this, the author proceeds to the determination of the coefficient of friction. The article contains several tables of data obtained from these experiments; among others, values of velocity of air, mechanical value of constants in the equation of curves cr-r and c^2r-r. Computation of the friction coefficient R and the table for converting the values of R given in engineering units to η (expressed in c.g.s. units). (*Über die Einwirkung eines Luftstrahles auf die umgebende Luft*, Dr.-Ing. Theodor Trüpel, *Zeits. für das gesamte Turbinenwesen*, vol. 12, nos. 5 and 6, pp. 53 and 66, February 20 and 28, 1915, 10 pp., 13 figs. *et*).

Hydraulics

Electrical Methods of Testing Hydraulic Turbines.

The guarantees given nowadays by manufacturers of hydraulic turbines are very strict and it is therefore of importance to have a convenient method for testing them, especially when in very large sizes. The author recommends to test electrically machinery driving electric generators, and describes a method for determining by means of very simple apparatus the losses and efficiency of alternating current generators and driving machinery coupled with it. He discusses in particular a case where a single phase synchronous generator was directly connected with a Pelton turbine provided with ellipsoidal blades and needle nozzle. The losses of the machinery, either electrical or hydraulic, were not previously known. The exciting current was in one instance taken from a separate source and in another, from an exciter generator driven by a belt from the main turbine.

With the water turbine (quantity regulation), the useful output varies, as experiments have shown, in the lower part of the curve, as a straight line function of the water volume and in its upper part, either as a straight line or as a line slightly curved (according to circumstances), the assumption being that the speed is constant and that at the turbine inlet there is a constant water pressure. The point of intersection with the axis of abscissae can be easily determined by measuring the water consumption of the turbine with the generator uncoupled. The lower section of the line of output has at first been assumed arbitrarily, starting from the no-load point of intersection (curve a, Fig. 2A). The turbine can now be temporarily considered as a calibrated motor and the no-load and short-circuit load of the generator can be determined with *first approximation* by means of this N_m line. These losses are shown in Fig. B as "1 results" curve. Next, a series of tests was carried out by varying the loads, and the useful output of the turbine N_m was determined on the basis of the output measured and the generator losses previously found (curve b, Fig. A). The exciter losses were not considered in this connection because they were taken care of by a separate machine. The fact that N_m line found with these load tests did not coincide with the line previously assumed shows that the line a was evidently taken too low. The friction, iron and copper losses, as found in the first four series of tests, were now corrected on the basis of the curve b, and the useful output of the turbine, as obtained from the load tests, changed in accordance with the corrected generator losses, this giving curve c in Fig. A. It must be pointed out in this connection that the tests themselves did not have to be repeated: only the calculation is repeated, and even this applies only to two or three small loads or losses. Curve c gives another basis for correcting the iron and copper losses. It is, however, clear that within the region used for the determination of the losses, the curves b and c would practically coincide provided the assumed curve a is not too far from actuality. This assumption may be made, for example, on the basis of the guaranteed efficiency of the manufacturers. This method is apparently nothing but the "regula falsi" applied to engineering measuring.

In connection with the carrying out of these tests, the following may be of interest:

First. The measurement of the volume of water was made by means of overflow with lateral contraction. Previous to the test, it was calibrated by means of a reservoir and points on the curve were taken for quite small amounts of water. It was found that the Frese coefficient of overflow agreed best with the experimental data.

Second. The head of fall was measured by a precision manometer in front of the turbine inlet. The fall was maintained constant by means of a slight throttling by a gate valve, located in the pipe somewhat to the rear.

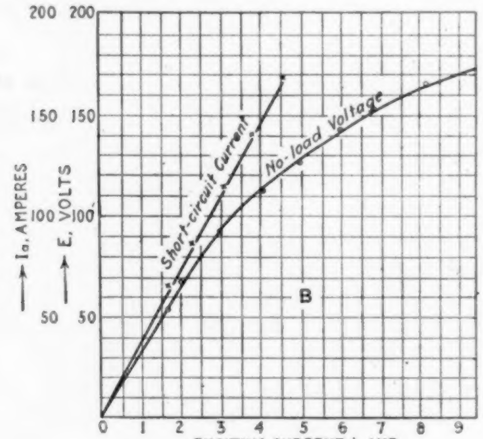
Third. A constant speed of rotation was maintained by adjusting the needle of the nozzle with a hand wheel until the tachometer indicated the desired speed.

Fourth. The alternating current produced was converted into heat in a non-inductive water-cooled wire resistance. The output as indicated by the watt meter was very nearly equal to the product of current voltage.

Fifth. With direct current, cold, the resistance of the armature winding was 0.026 ohms, while the direct measurement of the copper losses showed an effective resistance of 0.07 ohms, the difference being due to additional eddy cur-

rent losses and to the rise of temperature in the armature copper. These additional losses are taken care of by a corresponding increase in the value of the direct current resistance. Had they been neglected, it would have led to an error of considerable magnitude. With a load of 126 amperes, the difference would have been 0.7 kw., equivalent to an estimation of the efficiency of the turbine about 3 per cent too low. It is worth while to note that it appeared that the effective resistance of the armature increased with the smaller current, due to comparatively large iron losses at short-circuit in this particular machine.

Sixth. The electromotive force at load was calculated in the following manner. The total excitation field at load, which has to be applied as composed of the resultant field and short circuit field, in the present case expressed in terms of excitation current, is $i^2 = i_k^2 + i_r^2$. The short circuit characteristic (Fig. B) gives the short circuit exciting current i_k, corresponding to each armature current J. From the short circuit exciting current i_k and the exciting current i, measured on load, can be calculated the excitation component corresponding to the resultant field $i_r = i^2 - i^2$



and the emf on load which belongs thereto can now be taken direct from the no load characteristic of Fig. B. If instead of this emf on load be used the terminal potential, this will lead to establishing the generator losses as being too slow and hence the efficiency of the turbine will appear too low also. In this case, however, the error is usually small and amounts at maximum load to only about 0.6 per cent against the turbine efficiency.

In tests of large turbines it is not always possible to regulate, in a simple manner, the water resistances so as to obtain different loads at constant terminal potential. On the other hand, it is always very simple to get any load, however small, by exciting for small voltages with constant water resistance. If both methods of varying the load are practicable, a means of control of measurement of the generator losses is thereby additionally provided.

The efficiency of the turbine in the tests carried out by the author has been found comparatively small and he remarks in this connection that from full load to half load, it is 80 per cent, if the turbine is driven at its best speed of 500 r.p.m. with the designed head of 42.8 m. (140.3 ft.). The low efficiency may also have been due to the fact that the turbine and generator were not built for the same normal output (turbine for 16 kw. and generator for 20 kva.).

If the main turbine is to drive in addition to the generator the exciter also, the electrical measurements may be carried out in the same manner as above described, but the output of the exciter has to be determined by a separate series of tests. Such a test might have been carried out with the same apparatus as indicated above, a d.c. generator being driven from the turbine shaft by a belt. In the first place, one has to determine the losses of the exciter at no-load. After that, the exciter losses are determined separately and subtracted from the respective outputs of the first series of tests so as to determine the iron losses. This, however, requires the cutting out of the generator excitation in the second series of tests. To do this, the generator is uncoupled and the rotor set out of motion thereby. Then the field windings serve as a load resistance to the exciting current. In many cases where this cannot be done, it is necessary to have the exciter operate on a separate load resistance. Another method might be to repeat the first series of tests with separate excitation. This would give at once the iron losses and the exciter losses would appear as the difference between these outputs and those of the first series of tests.

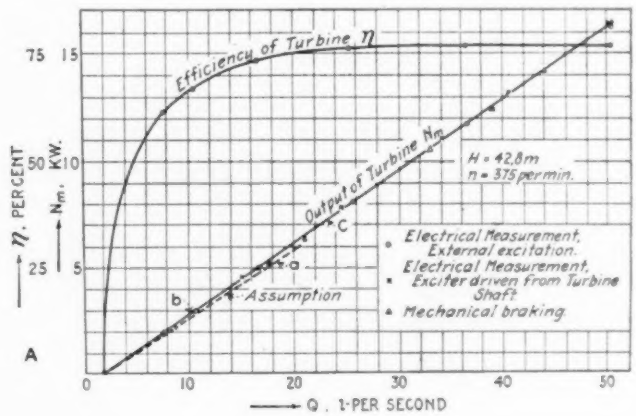


FIG. 2

A. Output and efficiency of free jet turbine at constant head: B. No-load and short-circuit characteristics of single-phase generator (n = 375 r. p. m.).

A method of measuring water by overflow used in the present tests proved to be extremely convenient and exact. In water power plants it is not always applicable, especially where the volumes of water are very large, in which case they have to be measured by vanes. In this case, the loss measurement of the turbine output may be determined as a function of some geometric magnitude, for example, servometer stroke or indicator position. The measurement of water volume may then be limited to definite tests of output. For exact measurements of the losses it must be assumed that the fall remains constant within the region of outputs used for the determination of losses, and it is also assumed that it is possible to read the indicator with absolute precision; that means that the scale has fine divisions and that there is no lost motion. Since, however, the connection between the indicator scale and water volume is not a linear one, a large number of the points at small outputs must be plotted in load tests so that the curve N_m line could be plotted as a function of indicator positions with sufficient clearness. (*Über Leistungsmessungen an Turbinen auf elektrischem Wege,* Dipl.-Ing. A. Strickler, *Bulletin, Schweiz. Elektrotechnischer Verein,* vol. 6, no. 3, p. 33, March 1915, 8 pp., 7 figs. *ed*).

Internal Combustion Engineering

BELLEM AND BRÉGÉRAS AUTOMOBILE ENGINE

The article describes an improved type of the Bellem and Brégéras engine.

A special characteristic of the Bellem and Brégéras engine is that it can use, without preheating, even the least volatile fuels and can start on ordinary kerosene. In order to attain this important result, the inventors have had recourse to the use of injection and to atomization under very strong suction. At each suction, a certain amount of liquid is carried by a pump into a special atomizing valve which opens only after the piston is down a certain part of its stroke, creating a considerable vacuum in the cylinder. Immediately after this, carburetted air is admitted, the rest of the cylinder volume being filled up with pure air through a second admission valve.

The difficulty which the inventors encountered at first

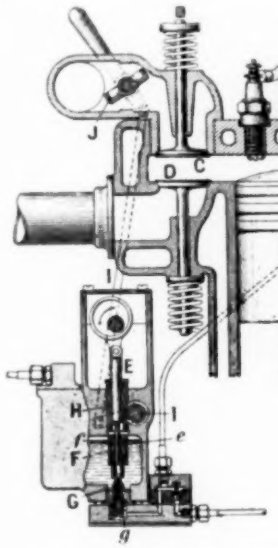


FIG. 3 BELLEM AND BREGERAS ENGINE

A, engine piston; *B*, atomizing valve; *C*, air admission valve; *D*, exhaust valve; *E*, rod of the pump piston; *e*, piston of the fuel feed pump; *F*, cylinder; *f*, cork protector; *G*, delivery flap valve actuated by the cylinder at the bottom of its stroke; *g*, valve spring; *H*, upper thrust block which can be governed by *I* and is connected with the air valve, *J*. (The pump takes in air at the bottom of the stroke, while the delivery occurs when the cylinder touches *G* and lifts it off its seat.)

was as to how to regulate efficiently the speed of the engine. In the original engine, this was done by a rather complicated device involving the use of a mercury column. In the present type shown in Fig. 3, this mercury column is eliminated and the regulation is effected by the construction of the feed pump which has a variable speed. As shown in the figure, it is of a reciprocating type with a plunger piston actuated by a connecting rod and eccentric, the cylinder centered about the piston with no connection to any fixed piece. Instead of any packing glands, there is a cork protector, which produces considerable friction between the cylinder and the piston. If not limited, the cylinder adhering to the piston, would move up and down with it without producing any pumping. Actually, however, two thrust blocks limit the motion of the cylinder, which latter naturally has to be deduced from the effective stroke of the pump. By varying the distance between the thrust blocks, one can vary the freedom of motion of the cylinder and thereby the effective stroke and output of the pump. It is very simple, of course, to change the distance between the thrust blocks and that is all the regulation which the new Bellem & Bregeras engine requires.

(*Perfectionnement au moteur Bellem et Brégéras*, A. W. *Omnia*, no. 445-28, p. 18, July 11, 1914, 1 p. 1 fig. *d*.)

Mechanics

LATERAL FLEXURE OF HOLLOW PIECES, Henry Lossier

The article discusses the subject of lateral flexure of hollow pieces and shows how errors in calculation may be made in this connection.

Metal or reinforced concrete constructions often involve elements under compression, constituted by two parallel members *A*, united at equal intervals by cross-pieces *B*, so as to form a rigid structure. Fig. 4M shows, for example, an iron structure in which the members *A* consist of channel irons and *B*, Fig. N, of double pieces of sheet metal. In Fig. O, the members are angle iron and the cross-pieces, sheet metal, crossing each other at right angles. In either case, each unit carries with it at least two rivets. Fig. R shows a hollow element of length *L*, containing four equal rectangles and being under the action of an axial compression *P*.

It is usual to compute the stresses on such an element by considering it as being similar to a solid prism having the same moment of inertia and then taking its resistance to lateral flexure as being equal to that of a trunk or length *f*, taken between two consecutive cross pieces. Such a method of computation which would be all right if the cross pieces were supplemented by diagonal members (indicated in Fig. R by dotted lines), would be correct for this case only if the flexure of the element occurred as indicated in Fig. S, that is, with the axis remaining rectilineal all through the deformation. Actually, however, the flexure will occur by a lateral bending of the axis, as shown in Fig. T.

Because of such a deformation the following takes place:

a The normal stresses, of which the initial value for each member is $P/2$, undergo a decrease in the convex member A' and a corresponding increase in the concave member *A*. This effect has its maximum value in the central trunks 2-2′;

b Because of the absence of diagonal stays and rigidity of the structure, *secondary flexures* occur both in the members and cross-pieces; these flexures, which are functions of the shearing stresses, reach their maximum values in the end trunks 1-1′.

The author recommends, therefore, for the calculation of such elements, the following formula and states that the fatigue of members will increase indefinitely as long as the stress *P* exceeds the critical value of P_t equal to

$$P_t = \frac{\pi^2 EI}{L^2}\left[\frac{\alpha}{1+\dfrac{I+2I_A}{2.5n^2 I_A}\cdot\alpha}\right]$$

where *E* is the modulus of elasticity of material, *L* length of flexure, I_A the moment of inertia of the member *A*, I the moment of inertia of the entire element,—that is the two members, A, $n = \dfrac{L}{f}$. α is a variable coefficient which is a function of the number of sections n, and has the following values:

n =	2	3	4	5	6	7	8	∞
α	1.62	1.22	1.11	1.07	1.05	1.04	1.03	1.00

This formula is not new and its first member is simply the Euler formula, giving the bending resistance of a solid prism having a moment of inertia equal to I. The second part, which will be referred to later on as k, has a coefficient smaller than unity, towards which it tends as the number of sections increases, so that for $n = \infty$, $k = 1$. In other words, k represents the ratio of the resistance of a hollow prism to that of a solid prism. The author recommends, therefore, the adoption of the following rule: *in a piece under compression, consisting of two parallel members connected into a rigid structure by cross-pieces located at equal distances from one another, the coefficient of permissible work is equal to the coefficient for a solid prism of the same moment of inertia multiplied by a coefficient k, less than unity, and given by the formula*

$$k = \frac{\alpha}{1 + \frac{I + 2I_A}{2.5n^2 I_A} \cdot \alpha}$$

From a numerical example, the author obtains curves shown in Fig. W, in which he uses for the upper curve (ordinary method) the Euler formula; next, the full drawn out curve represents what he would obtain with the formula proposed in this article, and finally the third curve is obtained by the Timoshenko formula (Annales des Ponts et Chaussées, May-June 1913), which the present writer uses in the form

$$P_{cr} = \frac{1}{\frac{L^2}{E.I.\pi^2} + \frac{f^2}{24E.I_A}}$$

obtained by neglecting the deformation of the cross pieces. This figure shows that with the exception of very small values of n, it gives results fairly close to those obtained by the Timoshenko formula which apparently tends to prove its correctness, as the Timoshenko formula is one of late date and apparent reliability. (*Etude du flambage des pièces. évidées*, Henry Lossier, *Le Génie Civil,* vol. 66, no. 10, p. 150, March 6, 1915, 2 pp., 8 figs. *t*).

Ball Bearings, Prof. J. Fischer-Hinnen

Investigation of the relation between axial and radial load on ball bearings.

Fig. 4 shows the state existing in an axially loaded bearing in a somewhat exaggerated manner. R is the radius of the tread, r radius of the balls, and $2a$ maximum distance between treads. It is further assumed that the distance $2a$ is by α per cent greater than the diameter of the balls, that is

$$a = \left(1 + \frac{\alpha}{100}\right) r$$

and therefore, because of the axial pressure P_a there appears a pressure component, directed normally to the balls, P_n of the magnitude

$$P_n = \frac{P_a}{\sin \beta}$$

The author further shows that the relation between P_a and P_n is determined by the following equation

$$P_n = \frac{2.2}{\sqrt{\alpha}} P_a$$

where 2.2 represents a coefficient which varies somewhat for different kinds of bearings (the author gives a table showing that), but may be taken to be equal to 2.2 for general purposes. This equation permits the determining of the additional pressure P_n when the axial pressure P_a and play α are known, and gives very interesting results. Thus, if the play is as large as 0.5 per cent, and the axial pressure is one third of the radial pressure, then

$$P_n = \frac{2.2}{\sqrt{0.5}} \cdot \frac{P}{3} = P$$

or the additional pressure is about 100 per cent of the radial pressure. Since, however, the manufacturers guarantee considerably smaller play, much greater additional pressures have to be looked for.

In the above connection, the author calls attention to the pitting to which the shaft on which a ball bearing is running is often subject, and which results in a surprisingly rapid wear of the shaft. Even though the gripping of the races against the shaft has been eliminated, very great wear of the shaft is nevertheless often the fact. It might have

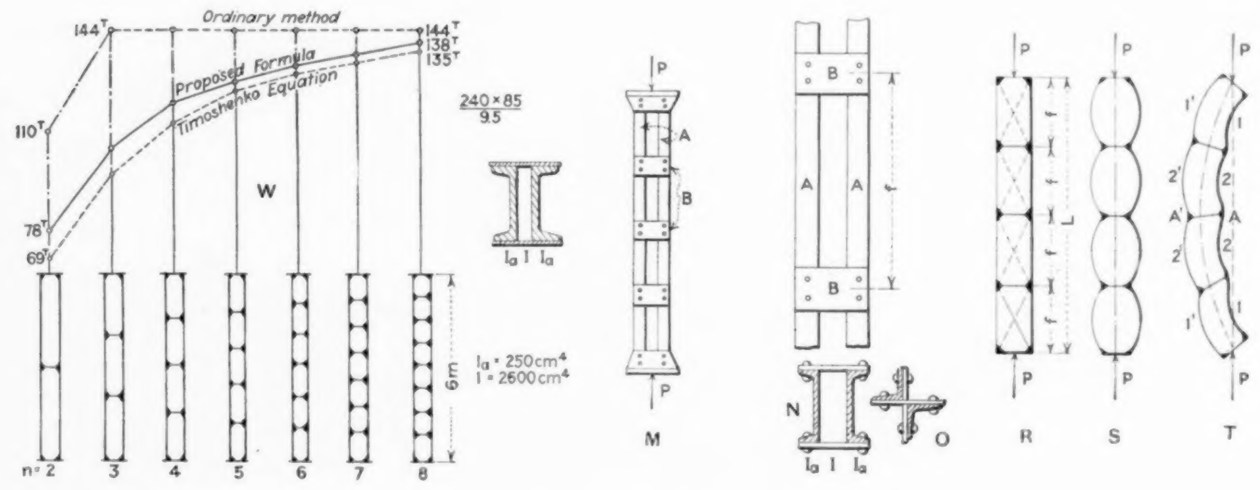


Fig. 4 Lateral Flexure of Hollow Pieces

been possible to ascribe it at first glance to the compression of material, but the low specific pressure at which ball bearings are run and the peculiar appearance of the surface of the shaft, which in places looks rusted and pitted, are against such an assumption. The author claims to have seen exactly similar conditions on shaft journals of engines not equipped with ball bearings and in which, after a run of only four or five hours, there appeared large rust spots and pits $^{1}/_{10}$ mm. deep.

In all of these cases it was found that the belt pulley was sitting pretty tight on the shaft. It would appear, therefore, that the cause of the wear of the shaft was electrolysis. In nearly all cases in which this phenomenon was observed, the engines were standing normally to the earth's meridian; that is, normally to the magnetic field of the earth, which, however, is not absolutely necessary for this effect because stray magnetic fields pass through the shaft anyway. It would appear, therefore, that in the boss, alternating current is generated. Since, however, the boss, because of its wedging, can have only a tilting motion in two directions,

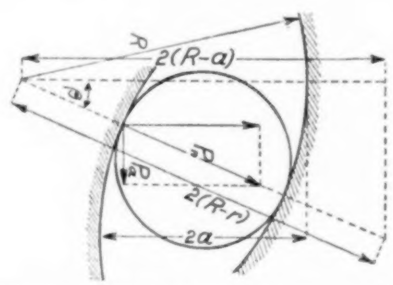


FIG. 5 INFLUENCE OF PLAY ON DISTRIBUTION OF STRESSES IN A BALL BEARING

there is, synchronously with the variation in direction of current, also a variation in the contact resistance; that is, the resistance at one change of direction of current is minimum and at another change is either maximum or infinite. We, therefore, have before us a kind of current rectifier which explains possible electrolytic action. If, on the other hand, the boss is loose on the wheel, both directions of current act at the same time and therefore there is no electrolysis. The same is the case with the races and ball bearings, and that is what this occasional excessive wear is due to. (*Über Kugellager,* Professor J. Fischer-Hinnen, *Elektrotechnik und Maschinenbau,* vol. 33, no. 12, p. 141, March 21, 1915, 2 pp., 3 figs. *tp*).

Steam Engineering

EVAPORATION TESTS WITH PEAT AND PEAT COKE AS FUELS, H. Winkelmann

Report of evaporation tests with peat and peat coke, carried out on saturated steam locomobile and fire tube boilers.

The engines were used to drive peat-making machinery and were designed accordingly. The boiler, designed like a locomotive boiler, was equipped with a large box-shaped fire box, similar to the so-called Colonial locomobile boilers for burning straw, sugar factory refuse and corn stalks. The grate was designed suitably for this kind of fuel and very generously proportioned. Since the peat can be burned with comparatively small amounts of air [theoretically 4.9 lb. per lb. of peat at 15 deg. cent. (59 deg. fahr.) and 73.5 cm. barometric stand., with ignition temperature between 220 and 240 deg. cent. (428 to 464 deg. fahr.) and temperature of combustion about 800 deg. cent. (1472 deg. fahr.)], the free grate area is kept pretty low, so as to have as little excess of air as possible. In fact, with peat, it amounts to only 1.8 times to twice the theoretically required amount of air, just as with other kinds of boilers in which fuel of low heating values (and therefore in large amounts) is used, and particularly large fire doors are here provided. Data as to the fuel are given in Table 1.

The tests, full data of which are contained in the original article, have shown that even when pressed peat is used, with a comparatively high content of moisture, it is quite possible to obtain a boiler efficiency (referred to the fuel burned) of 60 to 62 per cent and this efficiency rises to 67 or 68 per cent when peat coke of much higher heating value is used. In tests where peat coke was used, the grate was reduced in accordance with its heating value. There is no doubt, however, that still better results would have been obtained if it had been possible to raise the grate duty still higher. On the other hand, however, the good burning of the fuel may be explained by the comparatively low rate of combustion.

TABLE 1 ANALYSIS OF PRESSED PEAT AND PEAT COKE

Kind of Fuel.	Pressed peat.		Peat coke.	
No. of sample	I.	II.	III.	IV.
	In per cent.			
Carbon	40.3	38.2	82.2	81.8
Hydrogen	4.2	5.0	2.1	2.1
Nitrogen	0.7	0.8	1.1	1.0
Oxygen	28.4	30.4	5.2	5.2
Sulphur	0.6	0.4	0.5	0.5
Water	16.0	17.6	5.1	5.3
Ash	9.8	7.6	3.8	4.1
Combustible matter	74.2	74.8	91.1	91.6
Calorimetric heating value in calories per kg./B.t.u. per lb.	3080/5544	3110/5598	7128/12830	7015/12627

The author makes the following statement as to peat coke. It is a comparatively new material, produced in special coke ovens where, from each 30 tons pre-dried raw peat from 8 to 9 tons of coke are obtained, gas and tar being secured as by-products. The gas is used to heat the vertical coke retorts as well as to drive the engines, while from the peat tar are obtained gas and creosote oils, paraffine, methyl alcohol, pitch and sulphate of ammonia. (*Einige Verdampfungsversuche mit Torf und Torfkoks,* H. Winkelmann, *Zeits. für Dampfkessel und Maschinenbetrieb,* vol. 38, no. 10, p. 82, March 5, 1915, 2 pp. *e*).

Strength of Materials and Materials of Construction

MECHANICAL PROPERTIES OF TEAK WOOD, A. Weiskopf

The article reports an investigation of the mechanical properties of teak wood, carried out in the laboratory of the Hannover Car Company, in Hannover-Linden, Germany. The paper gives some data as to the manufacture of teak wood articles and its general properties, and then proceeds to report the data obtained from the investigation itself.

The extensive and growing introduction of teak wood for use in car construction in Germany made it desirable to obtain precise information as to its mechanical properties. The present investigation was somewhat curtailed in its scope by the coming of the war. These investigations covered compression strength, bending strength and tensile strength of the wood. For compression strength tests (Schenck testing machine) cubes 7 x 7 x 7 cm. or 10 x 10 x 10 cm. were used; for bending tests (same machine) bars 80 cm. long

and 8 x 8 cm. in cross-section; for tensile tests (Tarnogrocki testing machine) test bars 50 cm. long and 1 x 1 cm. in cross-section. All the tests were made on teak wood of two kinds, Indian and Java.

Separate tests were made on artificial drying of teak at a temperature of 50 deg. cent. for periods up to 40 days. The results obtained are tabulated in the original article and show that the loss in weight for a period of drying of one day amounted to 2.3 per cent. Then for the next two or three series of two to three days each this loss varied from 2 to 2.8 per cent, with a considerable decrease in the later stages of drying, so that in the last ten days of the test, it amounted only to 1.2 per cent, the total loss in weight after 40 days being 15.7 per cent. As regards the change in volume, no change was found in the length (in the direction of fibre, but parallel to the year rings), but 1.4 per cent was found in the width (tangential to the year rings), and 1.1 per cent in thickness (radial to the year rings).

The data of compression tests are given in the original article in the form of a table and two curves, one for Indian and another for Java teak. This table is not reproduced here.

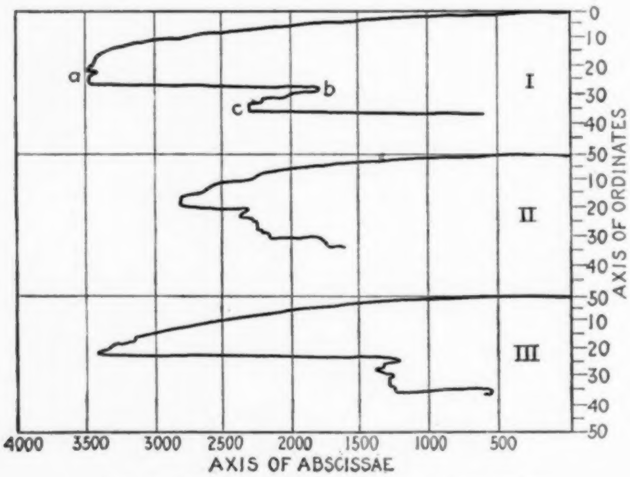


FIG. 6 BENDING TESTS ON INDIAN TEAK WOOD

There the stress in compression was applied in three directions, that is, in the direction of the fibre; normally to the fibre and radially to the year rings, and finally, normally to the fibre and tangentially to the year rings. It was found that the Java teak is stronger in compression than the Indian teak and can stand stresses as high as 479 to 498 kg/qcm. For the sake of comparison, the author quotes several kinds of other European woods, such as oaks, with a maximum strength of 327 kg/qcm, and foreign woods, Jarrah 321, Bongosi 599, Njabi 503 and Bang 444 kg/qcm. (the last three are grown in Kamerun, Africa).

The bending tests have been carried out on the same machine as the compression tests; their data are reproduced in a table and again in two sets of curves, of which the curves in Fig. 6 for Indian teak are here reproduced. The axis of the abscissae indicates loads in kilograms and the ordinates, bending in millimeters. In curve I, at the load of 500 kg., there is a deflection of 1 mm., while at 3000 kg. the deflection is already as high as 11 mm. At point *a* the maximum stress is reached, at a breaking load of 3450 kg. At that point the test piece is ruptured, as is indicated by a loud crack.

In addition to that, with the pressure radial to the year rings, the upper part of the wood in one of the year rings on one-half of the test bar became loose, so that the lower part of the bar appeared, at the conclusion of the test, to be pushed out forward. Next we see a brief backward run of the line; then a further bending of the bar and finally a longer backward motion of the line up to point *b*, to which corresponds a load of approximately 1720 kg. From here on, the test bar again becomes able to take up a larger load, which gradually rises at point *c* to about 2290 kg., after which a new backward motion of the line begins. As far as the useful strength of the wood is concerned, the diagram is of importance only up to the point *a*, but the rest of it is also of interest for the estimation of the quality of the wood in as far as it shows that the test bar, even at maximum load, does not break down entirely, and that rather only a part of the fibre is destroyed, while the other part still holds together and offers further resistance.

The results of tensile strength and rupture tests are reported in a table, both for Java and Indian teak wood. Such tests are rather hard to carry out because there is considerable difficulty in the preparation of the test bars, as it is difficult to cut them in such a manner that in the reduced cross-section bar the longitudinal fibres run parallel to the longitudinal axes. No tests have been made on the behavior of the wood under sand blasts. (*Untersuchungen von Teakholz in der Hannoverschen Waggonfabrik A.-G., Hannover-Linden,* Dr. techn. A. Weiskopf, *Glasers Annalen für Gewerbe und Bauwesen,* vol. 76, no. 4, p. 68, 904, February 15, 1915, 7 pp., 8 figs. *e*).

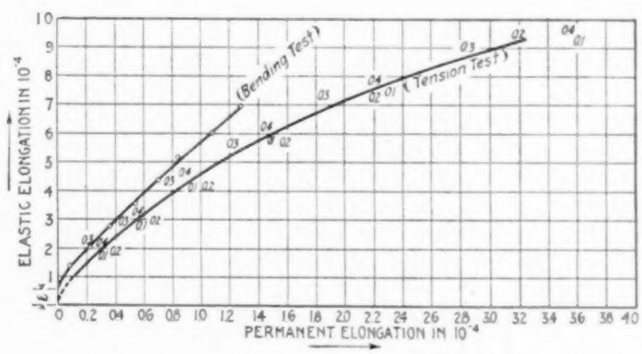


FIG. 7 ELASTIC PROPERTIES OF CAST IRON

BENDING ELASTICITY OF CAST IRON, Professor Akimasa Ono.

The article presents data of tests on tensile, compressive and bending strength of cast iron, and discusses the bending elasticity of cast iron. It also treats of the permanent set produced in cast iron by bending as well as the relation between the elastic and permanent sets in bending or tension. In his introduction, the author briefly summarizes the results of preceding investigations of Kármán, Bach, Pinegin, Herbert and Schöttler. The tests were carried out in the machine laboratory of the University of Fukuoka, on a 13,000-kg. Mohr and Federhaff testing machine.

The data of the tensile and compression tests are presented by the author in a number of tables. Among other things, he found that both the total and the permanent elongation, occurring at a certain stage of loading, materially increase with the number of repetitions, while the elastic elongation appears to have a much more regular behavior. Tables 2 and 3 respectively give a compilation of results obtained

from four tests each. If the equation $\varepsilon = \alpha.\sigma$ is used, in order to present the relation between σ and ε, one obtains from the above experimental data the following equations:

For tensile strength:

$$\varepsilon = \frac{1}{2690700} \cdot \sigma^{1.193}$$

and for compression strength:

$$\varepsilon = \frac{1}{1320800} \cdot \sigma^{1.049}$$

The author shows that the curves obtained from these equations nearly coincide with a curve obtained experimentally, the latter representing a purely elastic behavior of the material investigated.

From this, the author proceeds to explain his method of calculating the bending moments from the data of tensile and compression strength tests. He has also made a number of bending tests on test bars prepared from the same piece of cast iron from which the samples for the tension and compression tests were taken. In the preparation of all these samples, great care was taken to obtain a sound casting. The method of carrying out the test and the arrangements for taking fine readings is fully explained in the original article and the data of tests given in tables.

The author finds that the law $\varepsilon = \alpha\sigma^m$ is not so fully adhered to in tension as to permit its being used for a reliable expression of the elastic behavior of the material investigated. He also found that the constants α and m, in the above equation for elasticity, are different from those which Bach found for various test bars made of cast iron. Next he determined graphically, on the basis of the data obtained from tensile and compression tests, the relation between the moment of bending and the elongation of the extreme outward layer in tension of the bar under bending. The curves obtained in this manner were used in order to determine the elongation of the above referred to layer of fibres corresponding to every moment of bending. Naturally, however, this graphically determined elongation did not fully coincide with that actually observed probably because of unequal cooling of the metal.

A very remarkable fact was found that the permanent elongation observed in the extreme fibres and under tension during the bending test was considerably slighter than during the tension test. To illustrate this fact, two curves (Fig. 7) were plotted, showing the relation between the elastic and permanent elongation in tension and bending, and the comparison of these lines indicates the presence of an initial stress as well as the rise of additional stresses. Strictly speaking the data of tests, both on elasticity and on strength generally, cannot be clearly understood without taking into consideration these internal stresses.

Finally, the bending tests have confirmed the statement made by Schöttler to the effect that the permissible bending stress, k_b, is to k_z (permissible stress in tension) in a ratio different from $\frac{K_b}{K_z}$ (strength in bending and tension, respectively). (*Die Biegungselastizität des Gusseisens*, Professor Akimasa Ono, *Memoirs of the College of Engineering, Kyushu Imperial University, Fukuoka, Japan*, vol. 1, No. 2, p. 111, 1915, 54 pp., 13 figs. *te*).

TABLE 2 VALUES OF σ AND ϵ FROM FOUR TENSION TESTS

σ kg/cm²	ϵ (observed) 10^{-4}	ϵ (calculated) 10^{-4}	Difference between calculated and observed values	
			10^{-4}	in per cent of observed elongation
95.5	0.900	0.856	−0.044	−4.9
191.0	1.900	1.956	+0.056	+2.9
286.5	3.029	3.173	+0.144	+4.8
382.0	4.308	4.473	+0.165	+3.8
477.5	5.755	5.837	+0.082	+1.4
573.0	7.399	7.255	−0.144	−1.9
668.5	9.229	8.719	−0.510	−5.5

TABLE 3 VALUES OF σ AND ϵ FROM FOUR COMPRESSION TESTS

σ kg/cm²	ϵ (observed) 10^{-4}	ϵ (calculated) 10^{-4}	Difference between calculated and observed values	
			1−0⁴	in per cent of observed compression
97.3	0.938	0.922	−0.016	−1.7
194.6	1.883	1.908	+0.025	+1.3
291.9	2.878	2.919	+0.041	+1.4
389.2	3.918	3.947	+0.029	+0.7
486.5	4.998	4.988	−0.010	−0.2
583.8	6.028	6.039	+0.011	+0.2
681.1	7.148	7.100	−0.048	−0.7
778.4	8.213	8.167	−0.046	−0.6
875.7	9.283	9.241	−0.042	−0.5

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MARINE DRAFTSMEN

Journal, vol. 2, no. 1, April 1915, Washington, D. C.

The Diesel Engine, Dr. Paul Rippel
Machinery Arrangements, R. Entriken
Marine Engine Design, E. T. Cunliffe
Hulls for Aeroplanes, H. C. Richardson, U. S. N. (abstracted)

HULLS FOR AEROPLANES, H. C. Richardson

The paper reports tests on various hulls for aeroplanes, made at the Naval Model Basin since 1911.

The conditions of operation of aeroplane hulls are materially different from those met with in ordinary displacement work. In the first place, the speeds at which these hulls are used are very high,—from 45 up to and in excess of 60 miles per hour. Then, after a speed of 20 miles per hour is obtained, it is possible to control the trim of the hull so that it can be forced through the water at a different inclination than it would assume naturally. The most impor-

tant difference, however, is that while the load carried by the hull decreases practically as the square of the speed, this decrease in load is also a function of the angle of the machine with the horizontal and is, therefore, subject to change with change of trim.

The author produces several curves, together with the respective forms of the hulls, showing for typical conditions, the curves of resistance for one-quarter size models, run at various speeds. It has been found that in ordinary displacement conditions, the resistance mounts very rapidly after a speed of about 3 miles per hour, whereas the same model, run at fixed trim and displacement corresponding to speed, runs a little harder up to 3 miles per hour, but from that point on, the rate of increase of resistance gradually falls off and the resistance reaches at about 13 miles per hour, the value of 6.1 lb. as compared with 22 lb. under displacement conditions. From that on, the resistance rapidly falls off to practically nothing at 19 miles per hour, which is the speed corresponding to that at which the wings do the lifting. As regards step-type hulls and their tendency to "porpoise" under aeroplane conditions, a number of experiments have demonstrated that the ventilation of the step

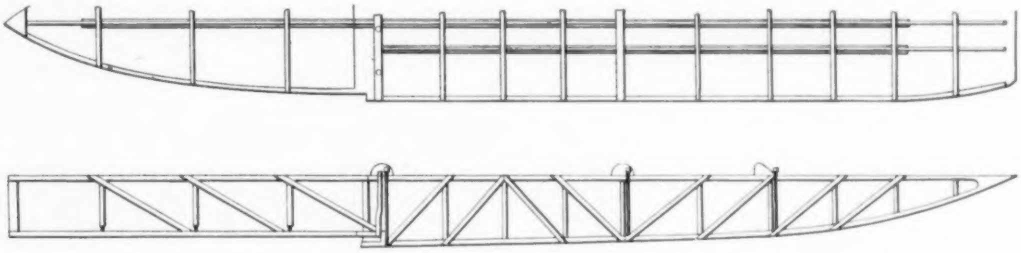


FIG. 8 AN AEROPLANE HULL OF FAIR EFFICIENCY

is not absolutely necessary but very desirable, as it allows of planing at much lower speeds than is practicable if no ventilation is provided.

The first series of experiments was worked out in January 1912. One of the earliest experiments made was that with the single hull of a semi-circular section, having ogival ends. It was expected that as the resistance at low speeds was primarily due to wetted surface, which became an important factor at high speeds because of the lift of the wings, a minimum wetted surface for displacement required might give good results. This proved to be correct at low speed, but when attempts were made to run this model at intermediate and high speeds, a new effect was found and the model, instead of having its resistance decrease as the speed increased, showed a remarkable increase in resistance and a strong tendency to settle back into the water, these effects becoming more and more pronounced as the speed increased. At about 9 knots, this model tried to submerge itself and at the same time lifted sheets of spray clear of the surface of the model basin, and thus demonstrated in a very exaggerated manner the difficulties to be met with when curved surfaces are exposed to the flow of water at high speed.

In another model, this difficulty was very much reduced by trimming it at the stern, although the resistance still remained high. The model tried on an even keel and trimmed at the stern showed a behavior better than any of the models previously tried. It was predicted that in a full sized model, a sharp bow would be unable to stand the thrust of the propeller and would tend to nose on that account, even though the center of gravity was placed sufficiently far behind the center of buoyancy to give a righting couple equal to the nosing moment of the thrust of the propeller when planing. This is what happened, but subsequent experiments showed that the reason for the nosing was due to the "heavier tail" and to the fact that the center of pressure under way was so near the stern that it was behind the center of gravity and thereby caused the model to nose. Many experiments with different shaped bows, flat, concave, convex and one of a freak corrugated type, showed that the shape of the bow could be varied in a wide range without seriously affecting the resistance.

An experiment was made to determine whether two models run as catamarans interfered with each other and it was found that at moderate speeds, the interference was slight and unimportant while at high speed there was practically none. Experiments with the ordinary Curtiss type and the beaver tail type showed that if the tail end of the hull was much behind the propeller position, it was impracticable to get the machine to leave the water because of the strong nosing tendency present at high speed. It was also found that such restricted length of hull would allow the machine to turn over backwards and as it was considered undesirable to use a tail float, it became necessary to obtain additional buoyancy at the stern in some manner which would not interfere with the getting away at the surface.

As a result, the model was run with rising fore and after body. This model behaved very well at high speeds, but the suction under the curved rising afterbody was so great as to cause excessive squatting, with the result that the propellers were brought dangerously near the water, which made this type unsatisfactory. To eliminate this difficulty, the same form of bow was used but the stern was tapered as shown in Fig. 8, this giving a sort of flat-iron stern and in order to break the suction around the stern, a step was formed at the side as well as under the bottom of the hull. This model behaved well at high speeds and satisfactory at low speeds on an even keel and on a straightaway course, but when an effort was made to turn the machine running at moderate speed, the water suddenly closed around the steps and gripped the left side of the tail of the hull. This effect grew with such sharpness that it spilled the machine over to its starboard bow and plunged the right wing into the water so that the machine was kept from capsizing only with the utmost difficulty. The above experiments emphasize the very powerful effect of suction.

As a result of the above work, a form of hull has been derived (not described) which appears to have decided advantages over those already in use in the Navy, so far as resistance on the surface and in the air is concerned.

The article contains tables showing the computation of the head resistances in water in detail for each of the models tested, as well as the frictional resistance, residual resistance and total resistance. The author comes to the following conclusions:

a The step should be close to the position of the center of gravity, to eliminate a nosing tendency, to facilitate change of trim while planing and to avoid change of balance when getting away or landing.

b Hollow V sections keep the spray down, cut the water more easily and cleanly, plane better, and greatly reduce shock on landing or when ploughing through broken water, and practically eliminate the necessity of shock absorbers. But in practice, care must be exercised to keep this sharp keel clear on side landings or when running on the nose, as this keel tends to bite suddenly and steer strongly.

c A shallow step is sufficient, but ventilation is essential to facilitate the breaking of suction effects.

d The bottom forward of the step should be inclined to the axis of the machine, but

e The inclination must not be so great as to cause planing before the controls are effective, and this is particularly necessary when running before the wind. If the planing of the hull is too pronounced, the machine rises to the surface with but very little control available to maintain balance, and when running before the wind this is more apt to occur due to the higher water speed necessary before the machine can take the air, yet sufficient reserve planing power must be available to enable planing without wing lift, or the hull will drive so hard as to be impossible to get away. These requirements are contradictory and call for a compromise.

f The bottom abaft the step should rise strongly as this favors a steepening of the planing bow before suction is eliminated, and gets the tail well clear when planing begins. (18 pp., 9 figs. *eA*).

AMERICAN SOCIETY OF NAVAL ENGINEERS

Turbine Electric Propulsion of a Battleship Compared with Other Means, P. W. Foote, U. S. N.
Motor Cylinder Lubrication, G. S. Bryan, U. S. N. (abstracted)
Tests of Matanuska Coal, U. S. S. "Maryland"
Description of the Repair Plant of the U. S. S. "Vestal", L. J. Connelly, U. S. N.
The Foundry Use of Non-Ferrous Scrap Metals, F. M. Perkins, U. S. N.

MOTOR CYLINDER LUBRICATION, G. S. Bryan

The article discusses the conditions under which lubrication in the cylinder of an internal combustion engine takes place and the characteristics of motor cylinder oils which determine the suitability for these conditions.

Trouble with lubrication in an engine can be traced to the following causes: poor design of engine and lubrication system, poorly refined oil, the improper supplying of oil to the cylinders, and oil of good quality but not suited to the particular type of engine. Trouble from any of the first three causes is unusual, while in the fourth case it can be easily corrected by using a different oil.

The action of heat on oils is indicated by two properties, the flash point and the fire point. It is important that the flash point shall be higher than the temperature of the inner surface of the cylinder, as otherwise the vapor given off by the oil will prevent it from adhering to the walls. It is, however, an old theory that was never founded on solid facts that the high flash point is a necessity in the motor oil or the oil would burn up without giving any lubrication. The author claims that the point was overlooked, that when we have a maximum temperature of gas in the cylinder of 2700 deg. fahr. and an average temperature of 950 deg. fahr., an oil with a flash point of 450 deg. will offer a little more resistance to burning than one with a temperature of 350 deg. Either oil will burn if kept for any length of time in contact with the hot gases, but lubricating oil does not burn rapidly and the time given for it to burn in a motor cylinder is very short. A thin film of oil smeared on a hot piece of iron or steel (300 deg.) will burn for several seconds if ignited. Few motors, however, ever run at less than 120 r.p.m., and at this rate, the average point of lubricated surface of the cylinder wall would be exposed to the action of the flame for only a quarter of a second, and therefore there is no danger of all the oil film being burned in so short a time, although some of it is burned, no matter whether the flash point is 300 or 500 deg. fahr.

A source of trouble is also the formation of carbon deposits in the cylinder, upon which subject a good deal of misinformation has been published. What is ordinarily known as carbon in the cylinders nearly always contains something else in greater or less quantity; for instance, rust and small particles of iron are nearly always found. In automobile motors a large percentage of dust is generally present and in marine motors, salt is a common constituent.

An oil that was considered unsatisfactory on account of a large amount of carbon formed in it has been recently investigated at the Naval Engineering Experiment Station and a chemical analysis of the oil from the crank casing that was supposedly full of carbon, gave results as follows:

	Per cent
Free oil	15
Water	12
Rust	11
Salt from sea water	58
Decomposed oil	2
Carbon	1
Foreign matter	1

Carbon may exist in a motor oil in two forms—as free carbon held in suspension or as a chemical part of the hydrocarbon compounds which go to make up the oil. Under the intense heat in the cylinder, the inner surface of the oil film is vigorously affected and in the absence of the air necessary for burning, three things might happen: *first*, the compounds may volatilize without decomposition; *second*, the compounds may decompose with the formation of free carbon and hydrogen; *third*, the compounds may decompose with the formation of other hydrocarbon compounds of a different nature. In the first case, the products will escape as gases; in the second, the carbon will be in a very fine state and be mostly blown out with the exhaust. Only when the compounds of decomposition, classed under the third case, form a gummy deposit, will the carbon stick to it and tend to make such a deposit thicker and harder and finally form the hard "carbon deposit." Where the compounds break up into new compounds, the nature of these new compounds will depend upon the properties of the oil. The oil that

will give the best results is not necessarily one that will form the least carbon but the one that will form the least carbon in the cylinders.

Oils made from Southern asphalt base crudes have shown themselves to be much better adapted to motor cylinders as far as their carbon forming proclivities are concerned, than are the paraffine base Pennsylvania oils. The carbon formed from the latter is as a rule extremely hard and clings to the metal surfaces, while that of the former is soft and can be easily wiped off any surfaces upon which it may be deposited. The cause of this lies in the fact that the paraffine oil bases are generally composed of paraffine series of hydrocarbons, while the asphalt base oils are composed mainly of the ethylene and naphthene series and one of the characteristics of these two series as compared with the paraffine series is their tendency to distill without decomposition. The lighter grades of motor oil are nearly equal in their properties, but in order to get oils with a high viscosity in the paraffine brands, it is necessary to compound the light oils in different proportions with heavier cylinder oil and it is the presence of this latter that is responsible for most of the gumming. The color and specific gravity of lubricating oils sometimes indicated in advertisements of oil companies are of no particular value to the consumer, although an expert can, from the specific gravity, in conjunction with the flash point, determine from what particular kind of crude, the straight oil is made. (14 pp., 1 figs., *H*).

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS

Journal, vol. 1, no. 3, March 1915, New York, N. Y.

An Aneroid Calorimeter, H. C. Dickinson and N. S. Osborne (abstracted)
The Specific Heat and Heat of Fusion of Ice, H. C. Dickinson and N. S. Osborne (abstracted)
A Standard Basis for Finding the Fuel Economy of Steam-Driven Ice Manufacturing Plants

An Aneroid Calorimeter, H. C. Dickinson and N. S. Osborne.

The paper describes a special calorimeter used by the author for the determination of the specific heat and heat of fusion of ice. (See next abstract.)

The most important feature of this calorimeter is the use of a shell of copper enclosing the specimen under investigation, the copper acting as a calorimetric medium for the transmission and distribution of heat developed in an electric heating coil which is built into the shell. Temperature changes in calorimeter and contents are measured by means of an electric resistance thermometer, likewise built into the shell. The calorimeter is suspended in the air space within an enclosing metal jacket while the multiple thermo-couples are distributed about the surface of the calorimeter to indicate at any instant the difference between the average temperatures of the surfaces thus enabling the corrections for thermal leakage between calorimeter and its surroundings to be controlled and measured.

The aneroid calorimeter, as this apparatus is called, is claimed to combine the following characteristics: it is applicable to both solids and liquids, even under high pressure; the same instrument, without changes, can be used over a wide range of temperature and by suitably adapting the jacket and the liquid used therein, this range can be extended over the region from the lowest temperature attainable up to +200 deg. cent and higher; the heat capacity of the calorimeter and contents can be measured over small temperature intervals, thus approximating the heat capacity at a definite temperature; troublesome corrections, due to the evaporation of the calorimetric liquid and to the energy supplied by the stirring device, are eliminated.

A series of check experiments on the specific heat of water shows the order of reproducibility of results which can be obtained with this calorimeter to be 1 part in 2,000. Measurements made at temperatures between 0 deg. and 40 deg. cent. gave results which agree to within the limits of experimental accuracy with the unpublished results of a long series of experiments made in the usual form of stirred water calorimeter. The results are also in satisfactory agreement with the most probable values deducible from the data of the most careful investigations published by other observers.

The original article gives the details of design and a diagram of circuits used, as well as tables of calibration of thermometers by the calorimeter. (27 pp., 11 figs.)

The Specific Heat and Heat of Fusion of Ice, H. C. Dickinson and N. S. Osborne.

The paper describes one of a series of investigations undertaken, at the request of the refrigeration industries, by the Bureau of Standards, at Washington, D. C., for the determination of constants which are of fundamental importance in the design and operation of refrigerating machinery. It refers particularly to the specific heat and heat of fusion of ice. A previous determination of the heat of fusion of ice made at the Bureau of Standards was published in 1913, at the time of the meeting of the Third International Congress of Refrigeration in Chicago. At that time, it was stated that the results presented were subject to a slight uncertainty on account of the lack of adequate knowledge of the specific heat of ice near the melting point. This has been the subject of the work described in the present article.

After a brief reference to previous work and a description of the calorimetric method employed (the aneroid calorimeter described in the preceding abstract was used), the authors proceed to the description of the material and the preparation of the samples, a matter of great importance in view of the fact that even small amounts of impurities are liable to cause a considerable increase in the apparent heat capacity due to incipient melting of portions of the ice. The experimental procedure used and methods of calculation are described in some detail and the experimental results, giving the specific heat of ice, are presented in several tables and diagrams, the tables expressing the observed mean specific heats of the several samples with reference to the initial and final temperatures θ_1 and θ_2 of the respective experiments ($S_m = \frac{H_2 - H_1}{\theta_2 - \theta_1}$ where $H_2 - H_1$ represents the total heat per gram over the interval $\theta_2 - \theta_1$).

A preliminary plotting of the observed mean specific heats indicated that the curves of specific heat were asymptotic to a straight line, the departure from which was apparent on the above temperatures varying from —8 to —2 deg. for various samples, which appears to corroborate the observation of Smith, that the specific heat of ice tends toward constancy as the impurities in the ice are reduced. As regards

the relation between apparent specific heat of ice and dissolved impurities, it has been assumed that the measure of the departure of the specific heat of a specimen of ice from a linear function of the temperature depends upon the degree of purity. While the results upon four samples of ice, all of high and yet different degrees of purity, agree with this assumption, it does not necessarily follow that the assumption is substantially correct and it is quite possible that the relation of the specific heat of pure ice to the temperature is other than linear, perhaps rapidly increasing near zero.

It has been found that at a given temperature, θ, between —40 and —2 deg. for the purest ice experimented on the specific heat, in 20 calories per gram per degree is represented within the limits of experimental accuracy by the equation

$$S = 0.5057 + 0.001863\,\theta$$

and that from —2 to —.05 deg., the specific heat for pure ice does not depart from the value given by the above equation by more than $\frac{0.004}{\theta^2}$. The specific heat of impure ice at a temperature θ above —40 deg. is greater than that of pure ice by lL/θ^2, where L is the heat of fusion, and l the initial freezing point.

The value found for the heat of fusion of ice is 79.76, *20 deg. calories per gram*, which is within $\frac{1}{4000}$ of the value previously determined at the Bureau by the different method, employing a stirred water calorimeter.

The original article gives the table of total heat of ice and water at temperatures for ice from —20 to + 32 deg. fahr. and for water from +32 to 100 deg. fahr. (29 pp., 7 figs. *e*).

CLEVELAND ENGINEERING SOCIETY

Journal, vol. 7, no. 4, January 1915, Cleveland, O.

An Example of Novel Shore Construction and General Talk on Jetty Action, Walter P. Rice
The Useful Recovery of Heat Losses in Internal Combustion Engines, J. B. Merriam (abstracted)
Founding as an Art and Adjunct to Engineering, Thomas D. West

The Useful Recovery of Heat Losses in Internal Combustion Engines, J. B. Merriam.

The paper describes a new method of recovering heat losses in internal combustion engines, and also discusses the causes of certain limitations in water cooling in the present engines.

It is a well-known fact that, with an ordinary water supply, an engine will work satisfactorily when the temperature of water is around 150 deg. fahr., but if the temperature of the water in the jacket is allowed to rise, the cylinder will burn or score even before the jacket water reaches, say, 250 deg. The elements which affect the flow of heat from the inside surface of the combustion chamber to and into the water are:

First. The difference in absolute temperature or the relation of the two temperatures to the absolute zero point. This is measurable, but not sufficient to cause a disastrous interference to the flow of heat which takes place somewhere between the surface of the combustion chamber and the water.

Second. The amount of surface exposed: in an engine already built it is constant, that is, it does not change with the change of water jacket temperature from 150 deg. to 250 deg., and therefore cannot affect the results when such a change takes place.

Third. The time of exposure: after the revolutions of the engine have been determined, it also becomes constant.

Fourth. The unit of resistance to the flow of heat: this appears to be the only element subject to change when the jacket water temperature materially rises.

To find out why it changes, the author refers to the familiar experiment of heating water in a rough cast iron vessel. It is there found that no visible change occurs below 140 deg. fahr., but above it, small bubbles are formed which adhere to the surface of the iron. These bubbles increase both in number and size with rise of temperature, and by the time the water has reached 200 deg., the inside surface of the vessel seems fully covered with bubbles.

The secret of the entire difficulty of running an engine

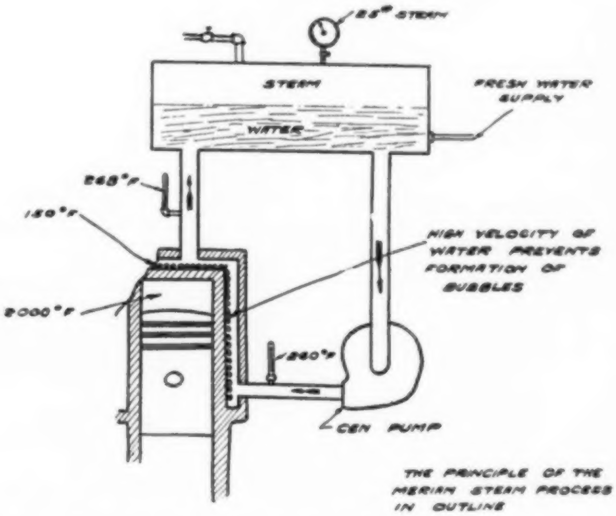


Fig. 9 The Merriam System of Recovery of Heat Losses in Internal Combustion Engines

with the water jacket temperature above 150 deg. lies in this formation of bubbles, since, if any portion of the surface continues to increase in temperature after the formation of the bubbles, spheroidal action takes place and thus constitutes a critical interference to the flow of heat, or, which is equivalent to it, to the cooling effect of the water.

It has been further observed that each of these bubbles increases in size and finally breaks away, and a new bubble rapidly forms on the same spot, which is somewhat hotter than the metal surrounding it, because it has been protected from contact with water by the previous bubble. If, however, the water is disturbed in the vessel so as to put it in motion, the bubbles break off while much smaller, the size of the bubbles decreasing as the velocity of the water is made to increase. Through these facts, the author comes to the conclusion that the formation of these bubbles and their adherence to the cylinder walls could best be prevented by very high velocities of the jacket water, which would permit both the using of higher temperatures of water and producing as a by-product a considerable amount of steam which can be employed for various purposes.

A series of experiments were made on a 150 h.p., 4-cylinder, 12¼ x 14 in. Bruce-Macbeth type engine, fully equipped

with thermometers, flow meters and gages, and a centrifugal pump which was used to force the water at high velocity through the cylinder jackets. The velocity of the water was maintained at from five to ten times that ordinarily used. The measurement was substantially as shown in Fig. 9. With this engine, it was found that it required less than 30 minutes to bring the system up to 10 lb. steam pressure, while in the other tests, the pressures have been increased to 50 lb., which is equivalent to a temperature of 297 deg. If an enclosed cooling system be used, as shown in the above figure, and only steam allowed to escape, then all of the water used must eventually be turned into steam and the entire amount of heat of the fuel, usually referred to as lost to the jacket water, will be fully recovered in the heat units restored in the steam. This appears to be actually the case. With a well designed exhaust-gas boiler, one-half of the 35 per cent of the total heat units of the fuel lost to the exhaust can be recovered and added to the 35 per cent recovered from the water jacket, which will give approximately 50 per cent of the total heat units of the fuel available in the form of low pressure steam. An exhaust boiler, or any low pressure or heating boiler, can be included as a part of the system.

At the same time, the efficiency of the engine as shown by

TABLE 4 RESULTS OF TESTS OF GAS ENGINE WITH WATER COOLING AT HIGH SPEED IN THE JACKET

	¼ Load	½ Load	¾ Load	Full Load
Brake h.p.	43	77	112	151
	17.[illegible]	12.[illegible]	[illegible]	9.[illegible]
Gas h.p. hour	14.3	11.4	9.78	9.28
Temperatures, deg. fahr.:				
Water supply	52	52	52	52
Inlet to cylinder	253	253	253	253
Outlet cylinder	260	262	266	267
Exhaust manifold	256	257.5	260	260
Steam pressure, lb.	17.5	17.75	18	18
Lb. of water evaporated per h.p. hour	7.3	5	4.3	3.7

Table 4, is also improved by this process, due to the higher temperature of the cylinders. The small figures show the gas consumption of the same engine when running with the cylinders at ordinary temperature. No difficulties or detrimental effects have been experienced when operating an engine under this process at maximum load and with the water jackets under full steam pressure and temperature. On the contrary, the resultant condition is favorable, since the water passes through the cylinder at such high velocity that the difference between the temperature of entering and outgoing water is less than 15 deg. and the cylinder and all parts of the engine are maintained at a uniform temperature. This temperature also remains constant irrespective of the load, as it is determined entirely by the steam pressure carried on the system. Another advantage claimed for this system is that the thermal efficiency of the engine is improved so that the fuel consumed is at least two per cent less at maximum load and fully 15 per cent less at one-quarter load as shown by tests.

A brief list of references on matters connected with the subject of the paper is appended to the original article (13 pp., 4 figs. *deA*).

ENGINEERS' CLUB OF PHILADELPHIA

Proceedings, vol. 32, No. 1, January 1915, Philadelphia

Air Conditioning, J. Irvine Lyle (abstracted).
Bituminous Coals, Predetermination of their Clinkering Action by Laboratory Tests, F. C. Hubley.
Reinforced Concrete in the Edison Fire, Percy H. Wilson.

AIR CONDITIONING, J. Irvine Lyle

The paper discusses present methods of air conditioning and then describes a number of applications of air conditioning installations. Its interest is in showing the wide field of application for this kind of apparatus and the valuable results which may be obtained with it.

The Lord & Taylor department store building, at Thirty-ninth Street and Fifth Avenue, New York City, is a good example of the application of air conditioning to a department store. With 82 deg. outside, inside the temperature was only 73 deg. and it felt cool and invigorating to a person coming in from the street.

There are many industrial plants in addition to textile mills where the question of humidity is of greatest importance. Four years ago there was not a bakery in the United States that was equipped for air conditioning. Today there are thirty odd bakeries having control of humidity in their dough-rooms, so as to regulate the germination of the yeast and prevent the gases generated in the raising process from being given off. On a commercial basis, figured on the continuous operation of a bakery, it gives about fifteen more loaves of bread per barrel of flour and makes whiter, better bread. The same applies to candies. Hard candies require low temperatures and low humidities for proper drying. For chocolates, low temperature must be provided in order to congeal it.

Control of humidity conditions is still more important in the case of macaroni. If dried too quickly, it will break all to pieces when the housewife gets it, and if dried too slowly, it is liable to mold. In printing establishments handling multicolor or lithographic work, the control of the humidity is absolutely necessary if they are going to turn out high grade work and do so continuously. In some cases as much as two months elapse between the time the first color is put on the paper and the last color is applied, and unless the temperatures and humidity conditions are maintained constantly uniform, it is difficult to obtain uniform results from the color plates.

From a hygienic point of view, air conditioning may also be very valuable.

In the stemming rooms of tobacco plants dust is so thick that the girls generally have to work with sponges or handkerchiefs over their noses. The machines are so constructed that it is practically impossible to remove all the dust, but such elimination as is accomplished is done by furnishing humidified air to the room. In a plant making cotton or straw mattresses, air conditions were so bad that they never had a man who was able to work two months in winter without losing a few days each month. The health department made them put in an air conditioning plant and now the men work continuously and there is no loss of time by the men.

Among other things, the author exhibited jars containing a week's dirt from the air in a public school in Brooklyn, showing the great need of air purification in such establishments (34 pp., 28 figs. *d*).

FRANKLIN INSTITUTE

Journal, vol. 179, no. 3, March 1915, Philadelphia.

Modern Views on the Constitution of the Atom, A. S. Eve.
Paints to Prevent Electrolysis in Concrete Structures, Henry A. Gardner (abstracted).

PAINTS TO PREVENT ELECTROLYSIS IN CONCRETE STRUCTURES, Henry A. Gardner

The paper describes a series of tests made to determine what type of coating is best suited for the protection of metal imbedded in concrete against the action of electrolysis.

The paper fully describes the method of testing. The rods, previous to bedding, were thoroughly cleaned from scale and rust, then two coats of paint were applied, allowing a week's time for drying between the coats. Cement mortar was prepared from one part of Portland cement and two parts sand. In making up the specimens for tests, the author considered the objection to using paints which dried upon the metal to a glossed surface, thus preventing a proper bonding of the cement. To overcome this difficulty, he applied to the painted surface while it was still tacky (not dried), sharp particles of sand or similar material which, when allowed to drain upon a painted surface, became attached to the paint and dried with it, forming a rough surface resembling coarse sand paper. Emery powder abrasives and other substances were tested, but fine clean white sand was found to be the most useful.

In the test specimens where cracking has occurred the anodes showed considerable rust, the paint coating originally applied having been destroyed. On the cathodes in series I (painted iron rods, $\frac{1}{2}$ in. in diameter and 12 in. in length, embedded in concrete cylinders, in upright position in mold, about an inch apart, and one inch from the bottom of the mold) the paint coatings were still intact, although some had apparently been affected by the moisture and the hydrated lime in the wet concrete, chalky surfaces being shown. Wherever there were small voids in the concrete, at or around the painted anodes, corrosion was most severe, and at such places pitting was evident.

The protective coating around the anode and cathode parts imbedded in the concrete cylinders which did not crack and which carried only a slight current, were found to be in a very good state of preservation. The breaking down of a film around the imbedded iron rods was always recorded by a sharp rise in amperage as well as by a fizzing sound, due to the increased evolution of hydrogen gas developed by the electrolysis of water in the damp concrete. This gas generally carried some water with it, forming small bubbles which burst with an audible explosion when a lighted match was placed in contact with them. The hydrogen gas seemed also to have a reducing or softening action upon some of the oxide bodies and carried to the surface of the cylinder considerable quantities of soft oily products which deposited around the anode and later hardened in contact with the air. Iron oxide was also carried to the top surfaces on some of the specimens by the action of the gas and water and was there deposited as a dark brown stain.

There can be no doubt that the nature of the paint films has considerable bearing upon the action of the hydrogen gas which was found to develop during the tests. Some paints gave good bonding tests but failed to act as insulators. Two lacquers composed of collodion and gutta-percha, respectively, dried to a flat surface, and gave a much better bonding than paints of a similar composition when dried to a glossed surface. Good bonding tests shown by several of the water paints are explainable through the wet concrete exercising a solvent action upon such paints, which gives opportunity for direct contact with the steel. Some paints which gave excellent results in the insulating tests gave conversely poor results in the bonding tests. Among these may be mentioned two paints composed of sandarac and shellac. Most of the oil pigment paints made with raw linseed oil gave poor or only fair results. It is probable that the raw linseed oil fails to dry hard, and although apparently well dried, remains in a semi-oxide condition so that the oil film is rather porous and therefore inefficient as insulation. Much better results were obtained with boiled linseed oil, a product which dries to a harder, less porous and more fully saturated film.

It is quite likely that the nature of the pigment used in a paint designed to prevent electrolysis of imbedded metal will have some bearing upon the results obtained from its use. Theoretically, pigments which are of a nonconducting nature should be preferable, such as inert pigments like asbestine, china clay and silica. There should also be present in a paint a sufficient quantity of rust-inhibitive pigment, (basic pigments or pigments of the chromate type), to produce a passive condition in the steel. The best results were given by protective compounds composed of processed and heat treated tung oil (Chinese wood oil) which dried to a hard nonporous film of a saturated nature. The author also recommends that the painted metal be "sanded" if possible.

The results of tests are reported in several tables. (24 pp., 14 figs. *eA*).

INSTITUTION OF PETROLEUM TECHNOLOGISTS

Journal, vol. 1, part 2, December 1914, London

Initial Equipment and Organization as affecting the ultimate success of Oil Development Companies, John Wells.
Oils from Peat, Dr. F. Mollwo Perkin (abstracted).

OILS FROM PEAT, Dr. F. Mollwo Perkin

The paper discusses the production of oils from peat and covers the chemistry of peat oil technology, work already done and commercial possibilities.

According to the statement of the author, there are many difficulties in the way of profitably extracting oil and other by-products from peat, but he does not believe that these difficulties are insurmountable. The initial difficulty and the one as a result of which most peat propositions have turned out failures, is to remove the large amount of water invariably held by the peat.

Here the question of economy of fuel must be taken into account. When peat is briquetted and dried so as to contain from 18 to 20 per cent of water, then on being charred, each ton produces from 5000 to 6000 cu. ft. of gas, having an average calorific value of 130 B.t.u. The process once started, the gas produced by carbonization is more than sufficient to continue the process and there is a certain amount of residual gas which can be employed for other purposes. But when the amount of moisture exceeds 20 per cent, the quantity of gas produced is not sufficient to carbonize completely the peat and extra fuel has to be employed.

On the plant of the Tarless Fuel Company, which is worked

under a considerable vacuum, peat may be carbonized satisfactorily and the by-products collected with a lower fuel consumption than when the distillation is carried out at atmospheric pressure.

How the water is to be eliminated in the first place is still an open problem. If the fibres are broken or disrupted, a much larger proportion of water can be forced out than from freshly dug peat, and a comparatively dry cake containing say from 30 to 35 per cent of moisture can be obtained. The peat can also be ground after it has been dug, without previous drying, the object of grinding being to break up the cells. Then the peat is briquetted and dried either by atmospheric exposure or by warm air. The author's experience is that peat briquettes should first be partially air dried before artificial heating is employed. Electrical processes have also been suggested for disintegrating the fibre. The labor item is a very serious element in all plans of making oil or carbon from peat.

The article contains a cost estimate for an experimental plant to produce 5 tons of dried peat per day for six months. (14 pp. *gp*).

SCIENTIFIC SOCIETY OF THE ROYAL TECHNICAL COLLEGE, GLASGOW

CALCULATION OF CENTRIFUGAL STRESSES IN TURBINE ROTORS, Wm. Kerr

The paper discusses the calculation of centrifugal stresses in rotors, solid shaft, hollow shaft or drum type. As the original publication of the Society before which it was presented is not available, the abstract is made from a reprint of the paper in the *Mechanical Engineer,* vol. 35, No. 897, April 2, 1915, and April 9, 1915, page 257.

In a rotating body, two principal stresses have to be considered—the tangential or hoop stress f_t and the radial stress f_r (fig. 10). An elementary portion of the body being considered, the stresses acting on the surfaces of it must be in equilibrium with the centrifugal force of the element, this condition providing a relation between the stress and the velocity, while the consideration of strains gives other relations. These are written down in the terms of the radial displacement of the material at any radius, the value of this displacement being referred to as *expansion* and denoted by the symbol u. From the consideration of velocity and strains, a differential equation is obtained, which, when integrated, gives a general expression for u, containing two constants to be determined by the boundary conditions which exist in each particular case.

The equations will always be found to divide themselves into two parts; one deals with the effect due to the mass of the rotor body alone and the other with the effects of the external loads which it carries, such as the blading. This is of considerable value as it enables the designer to recognize whether excessive stresses are due to loading or form. The following notation and constants are used by the author: specific weight of steel = .283 lb. per cu. in.; Young's modulus for steel = 30 x 10^6 lb. per sq. in.; Poisson's ratio for steel = 0.3; radial stress = f_r; tangential stress = f_t; expansion = u; external radius = R; ratio $\frac{R_o}{R} = a$; internal radius = R_o; ratio $\frac{r}{R} = b$; any radius = r; speed in r.p.m. = N; radial stress on external surface = ρ; total centrifugal force of rim and blades = Q; area of section of rim or drum = A.

Solid Shaft Rotor. The rotor body is composed of a solid shaft and the blading is fitted into grooves cut in the periphery. This means that a series of rings is formed on the surface of the shaft and in order to carry out the calculation, some assumption is necessary: either that the true radius of the shaft is the mean radius of the grooves, or the radius may be taken as that of the bottom of the grooves, in which case the collars are considered as an addition to the blade loading. The second method is perhaps the safer, as it leads to higher stress values. In the theory, consideration has to be given to a third principal stress; that is, the axial stress. Its equation is not given as it is of no practical importance,

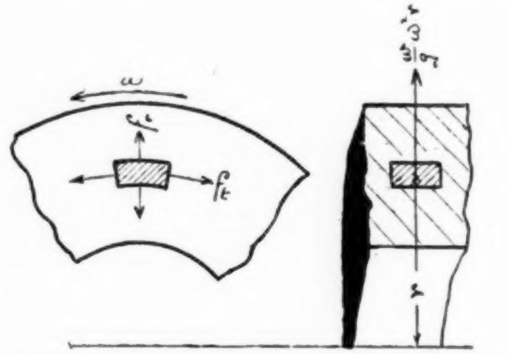


FIG. 10 CENTRIFUGAL STRESSES IN TURBINE ROTORS

but its influence on the radial and tangential stresses is considered in the determination of the expressions given for these. The general equations are:

For the radial stress at any radius r:

$$f_r = 3.46 \frac{N^2R^2}{10^6} (1 - b^2) + \rho.$$

For the tangential stress at any radius r:

$$f_t = 3.46 \frac{N^2R^2}{10^6} (1 - \frac{2}{3} b^2) + \rho.$$

Obviously, the maximum stresses are reached when $b = 0$ (that is, at the center of the shaft) and for these conditions, the radial and tangential stresses are equal, giving

$$f_r(\max) = f_t(\max) = 3.46 \frac{N^2R^2}{10^6} + \rho.$$

The article discusses an example of this type of rotor and gives in graphical terms the results of complete investigation of the stresses occurring in it.

Hollow Shaft Rotor. The difference between this type and the solid shaft rotor is that the inner core of the shaft is removed, either for the purpose of cutting down the weight or to insure the soundness of the material subjected to the highest stresses. In the formulae following, the symbol a represents the ratio of the inner radius to the outer radius, while b has the same meaning as before. The general relations in this case are

$$\text{Radial stress} = f_r = 3.46 \frac{N^2R^2}{10^6} \left\{ 1 - b^2 + a^2 \left(1 - \frac{1}{b^2}\right) \right\} + \rho \left\{ \frac{b^2 - a^2}{b^2(1 - a^2)} \right\}$$

$$\text{Tangential stress} = f_t = 3.4 \frac{N^2R^2}{10^6} \left\{ 1 - \frac{2}{3} b^2 + a^2 \left(1 + \frac{1}{b^2}\right) \right\} + \rho \left\{ \frac{b^2 + a^2}{b^2(1 - a^2)} \right\}$$

In the equation of radial stress, the maximum value of the first term occurs at a value of b different from that at which the second term reaches its highest value. Consequently, no exact expression of a simple nature can be given for the maximum radial stress. Since, however, the second term is usually of much less importance, the equation for the maximum might be made to suit the condition for the first term.

SOCIETY OF AUTOMOBILE ENGINEERS

Bulletin, vol. 7, no. 6, March 1915, New York

Automobile Warning Signals, Alden L. McMurthy.
Eight-Cylinder Engine, D. McCall White (abstracted).
Automobile Horns.

THE HIGH-SPEED, HIGH EFFICIENCY EIGHT CYLINDER V-TYPE ENGINE, D. McCall White

The paper, after discussing in a general manner the eight-cylinder V-type automobile engine, compares it with either the four or six cylinder engines. In the matter of size, the eight (the author refers to the Cadillac Eight) is enclosed in practically the same hood space as was the four cylinder engine. The length is no greater but there is about a two-inch greater width. The weight is 50 to 60 lb. less than that of the previous four cylinder engine. From a mechanical standpoint, the V-type eight has the advantage of permitting the use of a short sturdy crankshaft, having only four throws.

As regards cooling, each block of cylinders is treated as a separate unit, although one radiator is common to both. There are, therefore, all the advantages of the four cylinder construction without its disadvantages. Beside, in the V-type eight, the amount of space to be cooled in each cylinder block is so small relatively that the variations in the temperatures of the forward and rear cylinders need scarcely to be taken into account. The temperature of cooling water is controlled by a thermostatic arrangement similar to that in an aneroid barometer. Forced lubrication is used, an oil pump of the gear type driven at one-half engine speed, being situated at the lowest point on the front cover of the engine, which makes it very accessible for examination. The wrist pins, cylinder walls and camshaft rockers are lubricated by the residue oil which is constantly coming out from the end of the bearings. As regards durability, the author believes that a well designed and properly made eight will considerably outlast an equally well designed and made six. His reason for this statement is that vibration more than use shortens the life of a motor: in the V-type eight, properly designed and manufactured, vibration is reduced to an almost negligible factor, and hence to the same extent longevity is increased. (20 pp., 1 fig., to be continued. *d*).

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Journal, vol. 22, nos. 4-5, January-February 1915, Glasgow.

The Development of the Steam Turbine (discussion).
High Speed Steels, Fred. C. A. H. Lantsberry (abstracted).
"A Succinct Account of Huntsman's Cast Steel, 1792," Reprint.

HIGH SPEED STEELS, Fred. C. A. H. Lantsberry

The paper discusses the subject of high speed steels and presents a very clear and interesting historical and general review of the subject.

Among other things, the author describes an investigation made by him at the works of the Birmingham Small Arms Company with a view to determining the most suitable steel for the manufacture of milled twist drills. The properties required for a twist drill are more exacting than those required in a turning tool, in addition to which, in the turning tool the principal factor is undoubtedly hardness while in a drill mechanical strength and toughness are at least of equal, if not of greater importance. It appeared, therefore, necessary to test steels in a way adapted to this particular purpose.

Consequently, a special drilling machine was designed for the test, making it possible to obtain feeds of from 0.010 to 0.0675 in. per revolution and speeds of from 100 to 400 r.p.m. A standard drill size of $^{15}/_{16}$ in. diameter was adopted for the test, as being a size which is very largely used in English machine shop practice. A standard speed of 400 r.p.m. and a feed of 0.019 in. per revolution were adopted for the test in which the drills were lubricated, but in order to give some idea of the red-hardness of the various steels, tests were made in which the drills were run dry. For these tests, the same feed was maintained but the speed was reduced to 305 r.p.m. The number of inches of steel drilled was then taken as a measure of the suitability of that particular high speed steel for the purpose of drill making. In every case the drill was run until it absolutely refused to cut any more steel, when the point of the drill was quite worn away or the drill had broken.

A large number of proprietary steels were tested in this way but none of them were found to be particularly suitable for drill making. Special experiments were therefore made on the influence of tungsten, chromium and vanadium and the drilling properties of high speed steels, with carbon content as nearly as possible at 0.6 per cent. The first series of steels contained also constant chromium content, while the tungsten was increased from 10 per cent to 25 per cent. It was found that the efficiency of the steels as drills increased to a maximum and then fell as the tungsten passed 14 per cent. This figure was taken as the most desirable tungsten content, and upon this basis, another series of steels was obtained in which the chromium was increased from 1.5 to 7.5 per cent, the efficiency of the steel reaching a maximum and then falling off again as the chromium increased. It was found that the effect of molybdenum was slight and not sufficiently promising to warrant its use.

Altogether it was found that a really excellent high-speed steel is that containing 14 per cent tungsten and 4 per cent chromium, although the author does not claim that this is the best combination possible. Drills of the composition finally arrived at were deemed poor if they failed to penetrate 100 in. of the test steel. Further, the new steel would cut at a penetration of 25 in. per minute, while the ordinary steel would not cut at a greater penetration than 12 in. per minute.

In the discussion which followed, in answer to a question as to whether an addition of say 1 per cent of vanadium above the quantity eliminated in manufacture would be of any use, the author told of tests of a special steel containing 1 per cent of vanadium; drills made from it were of absolutely no use. It appears, therefore, that the only valuable effect of vanadium is that which it has during the process of making the steel. (24 pp., 8 figs. *hge*).

MEETINGS

CHICAGO, MARCH 19

A meeting of unusual interest was held by the Chicago local section on March 19, devoted to the subject of Refrigeration with special reference to Ice-Making as a By-Product of Central Stations. The meeting which was held in the ball room of the Hotel La Salle, was addressed by Heywood Cochrane, western manager of the Carbondale Machine Company, Chicago, who outlined the principal refrigerating methods in which ammonia is used as the refrigerant, then discussed the economies of usual ice-making practices with reference to the supplies of power, distilled water and steam, and finally explained the advantages of suitable combinations of such plants with power plants having excess exhaust steam available, with which important savings can be effected. Mr. Cochrane referred particularly to absorption machines and discussed a number of forms of installations of such apparatus in connection with steam plants, showing results and test data. He stated that in the case of a lighting plant with low revenue from the sale of current, the installation of a properly designed refrigerating auxiliary will prove more profitable than the original lighting plant, and in the case of a combined water and lighting plant, the addition of refrigerating equipment is even more advantageous. Mr. Cochrane's paper drew out a large amount of discussion, interesting addresses being presented by Otto Luhr and John M. Westerlin, both consulting refrigerating engineers of Chicago and by Fred Wittenmeier, vice-president and chief engineer of Kroeschell Bros. Ice Machine Co. of Chicago. A more complete account of the meeting will appear in an early issue of The Journal.

BUFFALO, MARCH 25

At a meeting of the Buffalo Engineering Society on March 25, an address on Our Navy and What it Means was delivered by Edward Breck, Field Secretary of the Navy League of Washington, D. C. Dr. Breck illustrated his address with a number of stereopticon slides, showing the progress of the American Navy up to the present time. He presented in addition some very interesting statistics regarding the growth of the navies of the world, as well as historical data which proved conclusively that preparedness is the best and only way to avoid war.

About 200 members were present at the meeting.

BOSTON, MARCH 31

At a local meeting in Boston on March 31, Harry Gay, equipment engineer in charge of the work for Stone & Webster Engineering Corporation, gave an illustrated talk on the Engineering Equipment of the New Technology Buildings; Geo. E. Libbey, of the firm of Hollis French & Allen Hubbard, presented the Heating, Ventilating and Sanitary Features of the Work; and A. L. Williston, President of Wentworth Institute, gave an illustrated talk on the Lay-out of Educational Institutions.

ST. LOUIS, APRIL 7

At a joint meeting of the St. Louis Engineering Societies on April 7, Edward E. Wall gave an extremely interesting paper on the City Water Supply. He spoke first of the steps necessary to bring to the highest efficiency the present water supply, which averages 120,000,000 gallons a day, with a maximum capacity of double that amount. The speaker advocated a new covered storage basin at Baden, additional pumps and pipe line, and the rebuilding, enlarging and covering of the Compton Heights Reservoir.

The requirements of ten years from now were next discussed. At that time, it is believed, the city's water requirements will be double the present amount. This increased supply can be obtained either from the Mississippi River by substantially duplicating the present plant, or from the Missouri River. The estimated cost of the two schemes is about the same, and since the Missouri supply presented a number of advantages, the author favored working along this line.

BUFFALO, APRIL 8

On April 8, the Buffalo Engineering Society accepted the invitation extended by the Federal Telephone and Telegraph Company and inspected the new automatic telephone system installed in their Buffalo plant. Mr. Hershey of Chicago presented a detailed explanation of the construction and operation of the automatic telephone apparatus and illustrated his talk with stereopticon slides. After the lecture a thorough inspection trip was made through the plant and the apparatus was shown and explained under operating conditions.

PHILADELPHIA, APRIL 12

A joint meeting with the Philadelphia Section of The American Institute of Electrical Engineers was held on April 12. J. S. Barstow read a paper on Turbine Driven vs. Engine Driven Units in Small Capacities. Mr. Barstow showed a number of slides illustrating the various apparatus mentioned. The paper was followed by a general discussion.

NEW YORK, APRIL 13

The monthly meeting of the Society in New York for April was devoted to the subject of elevators, with particular reference to the traction type of elevator machine used in the tall buildings. On account of the importance of this question in New York City, the paper attracted an unusually large audience, approximately 480 being in attendance. The meeting was addressed by David Linquist, chief engineer of Otis Elevator Company of New York, the subject of his paper being: Modern Electric Elevator and Elevator Problems. He took up first, the traction electric elevator, giving comparisons of the gearless traction type with the geared traction type, second, installations with details of their performance in service, efficiency, power consumption, acceleration and retardation, and third, the application of ball and roller bearings to elevator machinery. The address was profusely illustrated by lantern slides and drew out considerable discussion. A more complete account of the meeting will appear in an early issue of The Journal.

SAN FRANCISCO, APRIL 16

The San Francisco Section of The American Society of Mechanical Engineers held its spring meeting on April 16. The paper of the evening was read by G. C. Noble on the

Design and Test of a Large Reclamation Pumping Plant. The plant in question is that built for Reclamation District No. 1500, otherwise known as the Sutter Basin project, situated in the Sacramento valley near the confluence of the Sacramento and Feather rivers. This plant is probably the largest centrifugal pumping plant in the United States if not in the world, having a total capacity of 676,000,000 gal. of water per day, and requiring 5000 h.p. for its operation. Six 50-in. diameter pumps, operating against a maximum head of 29 ft. at a speed of 248 r.p.m., are direct-connected by means of flexible leather link couplings to constant speed motors. Duplex motor-driven vacuum pumps are employed for priming purposes and the plant equipment includes in addition the usual accessories. Mr. Noble's paper was illustrated by lantern slides. The entire subject is one of peculiar interest to Pacific Coast engineers.

NECROLOGY

JACOB ROBINSON ANDREWS

Jacob Robinson Andrews was born September 6, 1861, at Bridgewater, Mass., and was educated at Bridgewater High School and Bridgewater Academy. In 1879, he obtained employment as apprentice in the machine shop of the Hyde Foundry at Bath, Me. He was rapidly advanced to the position of foreman, and a few years later was made vice-president and general manager of the Hyde Windlass Company. When this firm separated from the United States Shipbuilding Company in 1905, he became president.

Mr. Andrews worked untiringly to advance the interests of American shipping and was one of the best known figures in shipping circles. He was a member of the Society of Naval Architects and Marine Engineers and the Engineers Club of New York. He died in New York City on March 25, 1915.

JAMES FINNEY MCELROY

James Finney McElroy was born in Greenfield, Ohio, on November 25, 1852. He attended the Salem Academy at South Salem, Ohio, in 1869 and the Bloomingburg Academy at Bloomingburg, Ohio, from 1870-1872. He was graduated from Dartmouth College in 1876 with the degree of A.B. and received the degree of A.M. from there in 1879. From 1876-1880, Mr. McElroy was principal teacher of the Indiana Institute for the Blind at Indianapolis and from 1880-1887 he was superintendent of the Michigan Institution for the Blind, at Lansing, Mich. For this institution, he designed and constructed the heating and power plant.

In 1887, he organized the McElroy Car Heating Company at Buffalo which operated under its own patents. In 1889, this concern was combined with the Sewell Car Heating Company forming the Consolidated Car Heating Company in Albany of which Mr. McElroy was consulting engineer and acting president to the time of his death. He died on February 10, 1915.

WILLIAM MCINTOSH

William McIntosh was born August 20, 1849, and had a common school education. From 1867 to 1870 he served an apprenticeship with the Chicago, Milwaukee and St. Paul Railway. He was employed by the Chicago and North Western Railway for 27 years, in the capacity of foreman at Waseca, Minn., and Huron, S. Dak., and of master mechanic at Winona, Minn. He left this position to become superintendent of motive power with the Central Railroad of New Jersey. When in 1909 he resigned on account of ill health, he claimed forty years of active railroad service. He died on March 16, 1915.

Mr. McIntosh was a member of the New York Railroad Club, the Canadian Society and the Engineers Club.

PERSONALS

Arthur W. de Revere has been appointed district sales manager of The Terry Steam Turbine Company, with offices in Chicago, Ill.

Daniel M. Luehrs has severed his connection with the American Blower Company, Detroit, Mich., as engineer in charge of the air washer department, and is now general superintendent of the Guilford Avenue Plant of the Crown Cork and Seal Company of Baltimore, Md.

M. C. Stuart, formerly assistant steam engineer at the Cambria Steel Company, Johnstown, Pa., has been appointed a mechanical engineer at the U. S. Naval Engineering Experiment Station, Annapolis, Md.

Claude A. Bulkeley has accepted the position of chief consulting engineer with the Canadian Domestic Engineering Company, Ltd., Montreal, Que., Canada. Until recently Mr. Bulkeley practiced consulting mechanical and electrical engineering in New York City.

Walter N. Cargill has been appointed superintendent of power and lines for the Rhode Island Company, Providence, R. I. He was until recently associated with the Stone & Webster Engineering Corporation of Boston.

Thomas H. Belcher has resigned his position with the Black-Clawson Company, Hamilton, O., and has accepted the position of manager of the Carthage Machine Works, Carthage, N. Y.

Homer S. Burns has accepted a position with the Freeport Sulphur Company, Freeport, Tex., as mechanical engineer. He was until recently in the employ of Westinghouse, Church, Kerr & Company, New York, as superintendent.

Clarence Boyle, Jr., formerly district sales manager of the Taylor-Wharton Iron and Steel Company, Scranton, Pa., has become associated with Clarence Boyle, Inc., Chicago, Ill.

Reginald J. S. Pigott is severing his connection with the Interborough Rapid Transit Company, New York, as mechanical construction engineer, to take up the position of power engineer for the Remington Arms-Union Metallic Cartridge Company at Bridgeport, Conn.

STUDENT BRANCHES

Members of student branches are requested to notify the Secretary of any change in address as promptly as possible, in order to facilitate delivery of The Journal.

ARMOUR INSTITUTE OF TECHNOLOGY

At a meeting of the Student Branch of Armour Institute of Technology on April 8, F. G. Gasche, chief mechanical engineer of the Illinois Steel Company, gave an illustrated talk on The Evolution of the Modern Steam Engine and Power Plant Transmission as Developed in the Steel Industry. Mr. Gasche told of the rapid development of the steam engine for blower purposes and showed how fast the D-slide valve and the Zeuner diagram were going out of use. The methods used in making I-beams, channels and steel rails were clearly demonstrated by the pictures shown.

CARNEGIE INSTITUTE OF TECHNOLOGY

The regular meeting of the Carnegie Institute of Technology Student Branch was held on March 10. Mr. Chester of Babcock & Wilcox Boiler Company read a paper on Modern Boiler Practice. He spoke first about the new A.S.M.E. Boiler Code, and told of many of the variations in boiler practice which it was designed to eliminate. In discussing boiler plants, he said that the large unit was desirable, but that it was usually broken up into a number of smaller units so that one or more could be held in reserve. Much progress is being made in combined boilers, superheaters, and economizers. Superheaters first became common in the United States in 1900, and at present about one fourth of the total boilers are equipped with them. Stacks are being replaced by mechanical draft, and more attention is being paid to the brickwork, so as to stop leaks, etc.; higher temperatures can be obtained than the fire brick will stand, and it has been found difficult to hold up the arches. By means of slides Mr. Chester illustrated many of the different types of boilers, settings, and stokers.

The meeting of the Branch, held on April 14, was one long to be remembered by the members, inasmuch as they were addressed by Dr. John A. Brashear, President of the American Society of Mechanical Engineers.

Professor W. Trinks first spoke to the graduate members briefly, explaining to them the advantages to be derived by becoming members of the A.S.M.E., and urging them to join the organization.

Dr. Brashear was then introduced and gave an interesting talk on Engineering as Applied to the Construction of Telescopes. He said, we need the civil engineer for location, the mechanical engineer for construction, the electrical engineer for control, and so on down the list of the various branches of engineering. His talk was illustrated by lantern slides. With the aid of these, he described astronomical instruments from their early crude forms to their present highly developed forms and showed the famous collection of Chinese instruments on the walls of Pekin, many of which had been taken by the various nations concerned in the Boxer Rebellion. He stated that every nation but Germany had returned these, and that he expected Germany to do likewise. For more than four thousand years the Chinese kept records upon which astronomers have placed great dependence. He showed and described many different types of telescopes, among them being those of Lord Ross and Sir Howard Grubb, the great forty-eight inch of Herschel, the twenty-six inch reflector at Lick Observatory, and the Snow Telescope at the same place.

Dr. Brashear dwelt for some time on the mechanical and electrical details of the telescope. It is no longer a difficult task to make observations with a large telescope. The observer merely sits in a chair and by simply touching buttons or moving levers, he can make these great masses take any position, hairline adjustments being easily made. If the telescope rises above the observer's eyes he can raise the floor to any desired level.

He showed the telescopic photographic apparatus, which he said had done so much for astronomy. The retina of the eye becomes tired very quickly, and hence visual observations are limited. The photographic plate, however, can be exposed to the action of heavenly bodies for many hours and thus receive impressions that otherwise could not be detected. In this connection, he spoke of the delicate gearing required for keeping the telescopes on the stars automatically and said that in the most carefully cut gears errors as great as one sixteenth of an inch appeared. This had to be eliminated by careful grinding.

He then showed views of his own shops, where much work in the construction of astronomical instruments has been done and is being done. Among these was that of a six-foot diameter mirror that was in the course of preparation. He told of the great accuracy and delicacy with which the various gratings, mirrors, and prisms had to be handled, laying great stress upon the effect of variations in temperature in the vicinity of these bodies. It is possible to measure to one millionth of an inch and to detect errors to one five millionth of an inch. He said that we must remember any machine that does the work for which it was designed is accurate enough.

Dr. Brashear explained why the mirrors used in astronomical work were of such great thickness, saying that the least flexure was obtained when the thickness was one sixth of the diameter. These large and valuable objects are shipped in loose packing in a box and this box is then packed in another box. This method has proved entirely satisfactory. He also described a simple method used in obtaining a plane surface. This is done by matching three surfaces, and using sodium light as a detector. Prof. W. Trinks, Mr. Estep and Mr. Williams took part in the discussion which followed.

CORNELL UNIVERSITY

The Cornell University Student Branch held a public meeting on March 10, at which Prof. H. S. Jacoby of the College of Civil Engineering addressed the members and their friends on the Maximum Spans for Different Types of Bridges. Supplementing his descriptions with lantern slides, he discussed the principal types of such structures from the simple plate-girder to the new Manhattan suspension bridge.

COLORADO AGRICULTURAL COLLEGE

At a meeting of the Colorado Agricultural College Student Branch on March 10, H. A. England gave a detailed and instructive talk on Mining Machinery. This included drills, drilling machinery, and methods of drilling holes and removing material. He spoke also of air compressors and pumps as used in mining.

Mr. Edmonson then gave an account of his visit to the plant of the Commonwealth Edison Company in Chicago. He discussed the coal and water supplies and the railroad facilities, and emphasized the immense size of the boiler plants.

LELAND STANFORD UNIVERSITY

At the regular meeting of the Stanford Branch of the American Society of Mechanical Engineers on March 23 C. J. Coberly gave a highly interesting and instructive talk on the history of Colored Photography and on his experiences in that line of work. He illustrated his talk with samples of his work.

J. A. Shepard spoke on his experience in hydro-electric work in Colorado, and the difficulties to be overcome in power plant operation.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

At a meeting of the Mechanical Engineering Society of the Massachusetts Institute of Technology on March 24, F. L. Fairbanks of the Quincy Market Cold Storage Company gave an illustrated lecture on The Design and Construction of a 1000-ton Ammonia Compressor. The possibility of making a larger machine of this nature without any assembly or even assembly drawing was discussed at length by Mr. Fairbanks, for it was in this way that he designed and erected the 1000-ton machine, which is the largest of its kind in the world.

OHIO STATE UNIVERSITY

At a meeting of the Ohio State University Branch on March 19, the following officers were elected for the ensuing year: H. Burnham, chairman; W. M. Leonard, vice-chairman; S. J. Cobb, secretary; M. A. Nettleton, treasurer; A. F. Landefeld, sergeant-at-arms. P. W. Sheatsley, secretary of the branch, gave a short talk on The Generating Plants of the Commonwealth Edison Company of Chicago.

PENNSYLVANIA STATE COLLEGE

The Annual Mechanical Banquet, given by the Juniors of the Pennsylvania State College Student Branch to the Seniors, was held on March 18. The toastmaster was V. D. Longo, '16, vice-president of the branch. The following toasts were given: Strength in Union by J. A. Mease, pro-

fessor of machine design; Our College by H. Diemer; New Methods by J. P. Calderwood, professor of mechanical engineering; Good Fellowship by E. D. Walker, dean of the School of Engineering; Locomotion by A. J. Wood, professor of railway mechanical engineering; Association by E. N. Bates, professor of mechanical engineering; State Students by O. F. Bourke, professor of economics; Engineers of 1915 by W. D. Garman, '15, president of the branch; and Engineers of 1916 by G. Jeffery, '16.

PURDUE UNIVERSITY

Charles J. Peck, M. E., '06, gave a very interesting talk on Valves and Other Fittings Used in Modern Piping, before the Purdue Branch of the A.S.M.E. on March 16.

Mr. Peck outlined very clearly the method of finding any required fitting in the catalogue issued by his company in which 16,500 articles for use in piping work are listed. All fittings are marked with the highest pressures they are designed to stand, and it is the duty of every engineer to see that the pressures are not exceeded.

To withstand these pressures many different materials are needed. Sometimes cast steel is used; sometimes malleable iron or cast iron will suffice. In all fittings where brass and nickel are used special grades of these materials must be provided to suit the different conditions. Hydraulic pressures as high as 5,000 lb. per sq. in. and temperatures of superheated steam upward of 750 deg. fahr. are often met with.

Mr. Peck next explained the fittings in detail. The most widely used piping formerly was wrought iron, but the modern steel piping has largely superseded it. Most piping now is of the flanged type and several examples were shown by the speaker. Section of gate and globe valves were shown; the former is more expensive and is used on water lines and on large steam lines; the latter is cheaper and is much used for smaller lines. The automatic stop valve for boiler work is a great help in power plant work, as it will cut in or out a boiler as the pressure reaches or drops below the line pressure.

The last branch Mr. Peck described was the modern tilting trap and the drainage and direct return types. The former is very simple, and operates to drain a line of condensed steam without the loss of live steam. The direct return type will force the condensed steam back into the boiler and is a much more efficient means than the ordinary duplex pump when pure water is used. The tilting trap can be used on anything from a heating plant to a modern power plant.

A meeting of the branch was held on March 31. The society was addressed by Frank Rasmussen of the Link-Belt Company of Chicago, who gave an illustrated lecture on The Elevating and Conveying of Materials.

Mr. Rasmussen is a graduate of the mechanical department of the State College of Colorado, and received his degree in 1901. His position with the Link-Belt Company has given him the opportunity to design conveyors for many new and difficult installations, and to investigate many other varied types of elevating machinery. He presented a number of lantern slides illustrative of the conditions commonly met with and of the types of conveyors installed.

Chain is the basis of nearly all conveyors. The common kinds are built up of detachable links, that breakages may be replaced. This detachable chain was developed originally for harvesting machinery to give a flexible as well as positive drive, but its worth has been so well proven that thousands of feet are made annually for all sorts of purposes.

Confining his talk to conveyors and elevators, Mr. Rasmussen illustrated many types of chains: Roller chains provided with hooks for car haulage in mines; flight conveyors, which scrape the material along in a trough to the desired location; the chain driven combination elevator and conveyor bucket, used especially for coal in power plants like that at Purdue; the overlapping platform conveyor for heavy materials at low speeds, like mine "picking," and the continuous bucket type for similar elevation.

Other types of conveyors for special purposes are the rope conveyors often used in bakeries in connection with spiral chutes. In this connection Mr. Rasmussen mentioned that a conveyor is being developed to run through an oven, that the baking may take place while the bread or cake is in motion, and may be a continuous process. The remaining conveyor which is used at all is the flat belt type, this being one of great capacity at all speeds. The last few illustrations outlined thoroughly the process of washing and drying coal in the modern mine.

L. D. Rowell, of the electrical department, gave a very interesting lecture on The Modern Battleship before the Purdue University Student Branch in the Mechanical building on April 13. He gave a detailed outline from the beginning of the iron clad vessel to the present time, comparing the ships of the United States with those of the other world powers.

The average American layman knows little about the United States navy in reference to its present condition or its development. He is oftentimes influenced by the more rabid newspapers into believing that the navy is useless and that the American ship yards know little about the construction of the modern warship.

Prof. Rowell proved conclusively that this statement was false. He started with the time of the Monitor and Merrimac. This battle was without a doubt one of the most unique naval conflicts ever fought, not because of the number of men killed or the decisiveness of the victory, but because it marked a new era in warfare. It marked the end of one type of vessel and the beginning of another.

Captain John Ericcson was the hero of the first battle of the Iron Clad. His name has gone down in history as one of America's greatest engineers.

Prof. Rowell compared very minutely the destructiveness and accuracy of the shells fired from the Iron Clad with those of the present day vessel. One broadside fired from a modern warship will do as much damage at six miles as a continuous fire from the Merrimac did in over four hours at point blank range.

The American Navy degenerated after the Civil War. It became the laughing stock of the world. It took twenty years to build some ships. The year of 1884 marked the beginning of the second era. Important steps were taken about this time to perfect the navy. The armored turreted battleship was introduced and the armored cruiser constructed. Among other types of vessels that have since been built are the hospital ship, the collier, the torpedo boat, the submarine, the destroyer and the dreadnought. Prof Rowell discussed these, explaining in detail the action of the guns of each type, their destructiveness, accuracy and speed.

The speaker stated that although the navy of the United States according to size, was not the strongest nevertheless it surpassed the navy of any other country in every other respect.

STEVENS INSTITUTE OF TECHNOLOGY

On March 9, James Hartness, president of the Jones & Lamson Machine Company, and past president of the Society, gave a lecture on Machine Tool Design before the Stevens Institute of Technology Student Branch.

On March 10, the Stevens Engineering Society conducted a party of students to inspect the plant of the Astoria Gas Light and Power Company, and another party on March 17 to see the process of manufacture of prepared soups at the plant of the Franco-American Soup Company in Jersey City. The last inspection trip of the year was made on March 24 to Jacob Ruppert's Brewery, New York.

UNIVERSITY OF CALIFORNIA

At a meeting of the University of California Student Branch on March 2, Eugene Arnot gave a talk on the Construction and Care of Exide Storage Batteries. Walter Allat spoke on the Construction of the Edison Storage Cell, and described tests which had been performed upon it.

At a meeting of the branch on March 30, John W. Dinsmore read a paper on Gun Powder Used in Big Guns, deal-

ing also with methods of projectile velocity measurement. The paper was discussed by A. C. Moorhead, H. L. McLean and Mr. Kennedy.

UNIVERSITY OF COLORADO

At a meeting of the University of Colorado Student Branch on March 25, the following officers were elected: Edison B. Good, president; Barrett Morrison, vice-president; C. Roy Goodner, secretary-treasurer.

Mr. Bagnall, salesman for the American Radiator Company in Denver, Colo., gave a brief history of Heating and Ventilation from the ancient Egyptians down to the present time. He said that the air valve for steam radiators as well as many others means of heating and appliances for steam radiators were the inventions of Colorado men, for instance the blast heating system. The United States leads in methods of ventilation, although some few ideas have come from England and Germany. The speaker suggested that radiators on account of their unsightliness be placed within base-boards, window-frames or door-frames. Typical problems of heating were given, showing the relation of the heat required to radiators, size of boilers, size and height of chimney and size of pipes. The various types and styles of steel and cast-iron boilers, valves, thermostats and temperature regulators were also discussed.

UNIVERSITY OF ILLINOIS

At a meeting of the student branch of the University of Illinois on February 26, the four-reel film, From Molten Steel to Automobile, issued by the Maxwell Company, was presented. This showed all the details in the construction of a modern gasoline car. Beginning with crude steel, the processes of casting and forging were shown in their entirety. After this, came the making of the various other parts such as the chassis and the minor engine parts.

At a meeting on March 12, H. T. Scovill of the accountancy department of the same company gave an address on Opportunities for Mechanical Engineers in Cost Accounting. In his opinion cost accounting and efficiency engineering offer a broad field for the technically trained engineer who is keenly observant and possesses the ability to handle men. The efficiency engineer reduces the cost of production by half. At the Ford factories men working at benches were spending four of their nine hours a day in walking, and the efficiency engineer was the man who saved steps. The man who can save time and money in production will benefit consumer and producer alike.

UNIVERSITY OF KENTUCKY

A special meeting of the University of Kentucky Student Branch was held on February 24, at which Calvin W. Rice, Secretary of the Society, gave a very interesting talk. He spoke first about the plans of the Society in forwarding the work among the student branches. The latter part of his talk was devoted to an account of the trip to Germany in 1913, and was illustrated with lantern slides. Among the most interesting views were those showing the German Museum in Munich which contains a working model of possibly every piece of machinery ever made. Each model is constructed so that the actual operation of the machine may be seen. An extraordinary feature of this museum is that no money has been donated by the government toward the collection of these models.

UNIVERSITY OF MAINE

At the last meeting of the University of Maine Student Branch, G. G. Holbrook of the Bath Iron Works delivered a very interesting and instructive lecture on Cost Estimates of Engineering. He divided his subject into the following topics: material, labor, overhead, margin, profit and delivery. The various methods of working out the cost of these several items were discussed by the speaker.

UNIVERSITY OF MICHIGAN

The University of Michigan Student Branch held a regular meeting on April 2 at which Prof. John R. Allen, dean of the Robert Engineering College of Constantinople, gave a very interesting lecture on Engineering in Turkey. The speaker first discussed the character and traits of the Turkish people, and then discussed the City of Constantinople, illustrating his talk with lantern slides. He told of the commercial facilities of the famous old city due to its excellent location. Constantinople has sixty-five miles of water front; the fronting on the Bosphorus being especially valuable as the Bosphorus is deep right close to the shores.

UNIVERSITY OF MINNESOTA

On March 3, an open lecture under the auspices of the Minnesota Student Branch was given by a representative of the Carborundum Company to the whole Engineering College. The lecture was illustrated with lantern slides, and showed in great detail the manufacture of the carborundum itself and that of the various types and sizes of grinding wheels used.

On March 11, the branch held a meeting at which Prof. W. T. Ryan, of the department of electrical engineering, spoke on Diversity Factors in Central Station Operation. The diversity factor shows the ratio between the power actually used by a consumer and that which the apparatus installed for him can give if called upon. The factor has been investigated for a number of cities, and Professor Ryan has carried out such an investigation for the principal cities and towns of Minnesota. The lecture was exceedingly interesting and practical.

On March 18, under the auspices of the branch a reel of Ford films was shown to the Engineering College. Prof. S. C. Shipley of the mechanical engineering department, who visited the plant last summer, gave an explanation of the film. The lecture showed the famous assembling conveyor which makes the "1000 cars a day" possible. It also showed the complete assembling of a car from the point where the frame is placed on the conveyor to that where the car runs out of the shop under its own power. The audience filled the Engineering Auditorium to capacity.

UNIVERSITY OF MISSOURI

At a meeting of the University of Missouri Student Branch on March 25, W. A. Sloss gave a talk on The Oil Industry. He described the methods employed in prospecting for oil, opening new wells and installing machinery, and explained the work in detail up to the delivery of the crude oil at the refinery.

WORCESTER POLYTECHNIC INSTITUTE

By invitation of the Alumni and the local members of The American Society of Mechanical Engineers, the Worcester Polytechnic Student Branch were present on April 8, at the organization of the Worcester Section, Am. Soc. M. E. Ex-Mayor James Logan, Manager of the United States Envelope Company, presided. He spoke briefly of the need of an organization to bring together the varied engineering interests of the locality; and then called upon Dr. Ira N. Hollis, President of the Worcester Polytechnic Institute, who called attention to the help which this section could give to the engineering college of which he is the head and especially to the Student Branch.

Calvin W. Rice, Secretary of the Society, was introduced and spoke of the value of the various local sections of the Society, placing particular emphasis upon the growing interests of the professional engineer in civic affairs.

An interesting address on the Submarine was given by R. H. M. Robinson, formerly Naval Constructor, and now general manager of the Lake Torpedo Boat Company. The speaker began with a historical sketch of the submarine, the first successful one being that of David Bushnell, in 1773, followed by Robert Fulton's submarines. He then gave a brief description of the various submarines being built in the United States, Germany, France and Italy, and supplemented his description with lantern slides showing the five types of submarines. These are the Holland and the Lake, which are built in the United States; the Lebeif, the French boat; the Krupp-Decevilley, Germany's type of boat; and

the Fiat-Laureti, which is of Italian design. There is practically no protection for a battleship against a submarine. The battleship of the newest type represents an expenditure of about $16,000,000 and this great fighting machine can be put out of commission, if not sunk, by a single torpedo from a submarine. The United States is building submarines which will have a cruising radius of from 4000 to 5000 miles. The German submarines have been working in a radius of from 1100 to 1200 miles and this is considered remarkable. While it is not probable that the present submarine is all that is necessary in naval warfare, it is a beginning of a new style of naval armament. For motive power, submarines depend upon storage batteries and combustion engines, but it is likely that steam driven submarines will soon be built. There have been steam submarines, but with poorly developed engines and boilers, they were found impracticable. With the newer developments in steam engines and high pressure boilers, however, the steam type will be a success.

Commodore Robinson said he believed that the German submarines were using a short range torpedo with an extremely heavy charge for operating against war ships, but with an extremely light charge when attacking merchant vessels. He called the Whitehead torpedo the best developed mechanism in the world and told of the exhaustive tests given each torpedo before sending it out to be used.

EMPLOYMENT BULLETIN

The Secretary considers it a special obligation and pleasant duty to be the medium of assisting members to secure positions, and is pleased to receive requests both for positions and for men. Copy for the Bulletin must be in hand before the 18th of the month.

POSITIONS AVAILABLE

The Society acts only as a "clearing house" in these matters and is not responsible where firms do not answer.

In sending applications stamps should be enclosed for forwarding.

059 Mechanical engineer and chief draftsman in the engineering department of large industrial concern. Prefer man who has had several years experience in design and application of coal and ore handling apparatus, ore and slag crushers and blast furnaces; steel, brick and wood buildings, bridge work and general steam and power plant engineering. Name confidential, apply by letter.

088 Assistant works manager for firm manufacturing cranes and electrical specialties; A-1 man with engineering experience in structural, mechanical and electrical work, and previous work in connection with modern manufacturing methods. Location Michigan. Apply through Society.

093 Experienced mechanical draftsman, capable of doing some designing; one preferred with experience in machine tool and shop practice and with a fair technical knowledge. Location Connecticut.

099 Professor of mechanical engineering for Southern University. Apply by letter.

0101 A large manufacturing concern wishes to engage as employment head, a man of special ability in the selection of labor, to be permanently located at the factory. Should be able to select men of proper character, who would have the training for the different classes of work carried on in the various departments. Apply by letter stating age, experience in full, and salary wanted. Location Philadelphia. Name confidential.

MEN AVAILABLE

The published notices of "men available" are made up from members of the Society. Notices are not repeated except upon special request. Names and records are kept on the office list three months, and if desired must be renewed at the end of such period.

E-72 Junior, M.E. graduate Lehigh University, several years experience as draftsman, chief engineer's assistant, foreman and manager, at present located in prominent technical institution in New York, desires summer position which would afford experience in the mechanical field. Salary and location immaterial.

E-73 Junior member, age 26, Brown Univeristy graduate with experience in the design and inspection of power plant construction, desires position where experience in testing and operation can be obtained.

E-74 Member, age 34, technical education, married, with broad experience with leading engineers in the East on the design of steam power plants, heating and fire protection systems and inspection of mill and power plant construction and equipment, desires position with large manufacturing or engineering concern; at present employed as superintendent of construction on large mill and power plant.

E-75 Member with wide experience in the design of all manufactures of engines and power plant work, desires position with company engaged in gas or steam engineering; would also consider offer with a consulting engineer.

E-76 Member, graduate mechanical engineer, 20 years experience as designer and chief draftsman with leading manufacturers of simplex and duplex steam pumps, desires position.

E-77 Graduate M.E., age 39, 15 years consecutive and successful experience from shop apprentice to agency manager; with one large corporation nine years, manufacturing steam and producing gas engines, producer transmission and special machinery; has held positions as draftsman, designer, estimator, sales engineer, mechanical engineer and agency manager; also experienced in efficiency engineering. At present employed but desires change.

E-78 Associate-member, Stevens graduate, age 27, has had practical experience in all departments of gas engine manufacture, designing, machine work, assembling, testing and sales work, desires position as assistant to factory manager or to superintendent. Will begin at salary of $1500. At present employed.

E-79 Stevens graduate, 1883, with experience as superintendent of bridges and buildings, and one who has specialized in railroad shop design, construction and equipment, desires position.

E-80 Member, sales engineer, thoroughly familiar with business methods and present conditions of Scandinavian countries and Russia, desires to represent firms manufacturing machine tools, power and transmission machinery, small tools and general supplies.

E-81 Member, graduate Massachusetts Institute of Technology, 1901, age 35, married, desires position about May 1st as works manager or general superintendent of large manufacturing plant; experience as such covers about 12 years. Familiar with up-to-date methods of shop management. Has successfully handled from 1000 to 1500 men.

E-82 Member, technical graduate, age 36, mechanical and electrical engineer thoroughly practical, original and efficient, 13 years experience in responsible capacity, designing, manufacturing and selling water turbines, governors, penstocks and accessories for hydro-electric installations; also experienced in making preliminary surveys, reports, efficiency tests and investigations of power propositions, writing specifications and purchasing material, desires position where these qualifications, coupled with executive ability are desirable. With present employer 12 years. Location preferably East or South.

E-83 Associate-member, age 42, experienced in superintending masonry, concrete, brick and steel construction, also installation and maintenance of mill machinery, drafting, foundry, forge, pattern, machine and bridge shop-work, desires position.

E-84 Associate-member, engineering graduate, experienced in general engineering and teaching, desires position for the coming academic year in mechanical department of a technical school.

E-85 Junior member, age 31, considerable experience in foundry and core room operation, equipment design and installation, pattern making, foundry costs, etc., wishes position with large company operating malleable or grey iron foundries. At present employed.

E-86 Member with broad and thorough manufacturing experience from apprentice to general manager in foundry, pattern, machine, blacksmith, boiler shops and drawing office, positions which called for initiative executive ability, tact, the handling of correspondence, organization of men and the direction of their work, wishes employment as manager, superintendent or other executive position. Location immaterial.

E-87 Member, 25 years valuable and complete experience in design and construction of electric traveling cranes, rolling mill machinery, special machinery, etc., desires position as chief designing or mechanical engineer, or in any other capacity where experience would be of value.

E-88 Mechanical engineer, Stevens graduate, age 30, married, seven years varied experience having specialized in pressed steel, both light and heavy; at present holding responsible executive position as plant engineer with small manufacturing concern. Desires a position along similar lines, or one as assistant to superintendent or manager with company offering opportunity for advancement.

E-89 Member, Cornell graduate, age 38, married, nine and one half years experience in railroad shop, testing laboratory, drafting, supervision of power plant and foremen; two years construction work, design and installation of equipment in steel mills, desires position in mechanical department of railroad, manufacturing concern or firm of engineers.

E-90 Factory superintendent or general foreman with broad experience in modern manufacturing methods can produce results with equipment; 12 years experience with production efficiency, organizing, designing tools, and labor saving devices for decreasing of costs.

E-91 Member, technical graduate, with wide experience in design and supervision of heat, light and power plants, also eight years experience in efficiency engineering desires position with consulting engineer or with private firm.

E-92 Junior member, M.E., command of the English and German languages, some knowledge of typewriting and stenography, three years in charge of the mechanical laboratory in a University in the middle West seeks a position with a firm with opportunity for advancement; willing to start at the bottom and work up. Location Eastern states.

E-93 Sales engineer, age 30, married, with wide acquaintance in the South Eastern states, experienced in handling steam, gas, hydraulic and electrical equipment for largest builder in America wishes to locate permanently in his native South in capacity of district manager, or sales agent for similar or allied lines. At present employed but desires change solely for personal reasons.

E-94 Member with experience as superintendent and factory manager thoroughly familiar with modern methods in manufacturing, efficient shop organization and management, desires position.

E-95 Junior member, graduate in mechanical and chemical engineering, four years teaching experience and summer work in power plant, irrigation work, etc., desires position in mechanical-chemical industry. Available after June 15.

E-96 Junior member, graduate mechanical engineer, post graduate work in management and efficiency engineering at Harvard University; drafting room, pattern and machine shop experience, desires position as assistant to works manager or superintendent with an opportunity for advancement by conscientious work and the proper initiative in superintending and increasing the efficiency of production.

E-97 Junior, technical graduate, possessing executive ability, 12 years varied experience in design, construction, operation and maintenance of power houses and sub-stations; familiar with up-to-date methods of mapping and execution of construction and repair orders in power plant and mill accessories, experienced in testing and experimental work, desires position of power engineer, assistant superintendent, assistant manager or works manager. At present employed. Location preferred, New York or vicinity.

E-98 Student member and technical graduate desires employment with engineering or manufacturing company; willing to start in right position at low salary.

E-99 Junior member, mechanical engineer, University of Illinois graduate, age 25, with thorough knowledge of foundry, core and machine shop methods and details, experienced in cost and efficiency work, sales, purchasing, etc., desires position as works manager, or as assistant manager of sales.

E-100 Associate-member, graduate mechanical engineer, 12 years general engineering experience as designer, erection superintendent, assistant general superintendent, consulting and efficiency engineer, would consider position as chief engineer, works manager or similar responsible position with progressive concern.

E-101 Member, 34, married, technical education, 14 years experience in the design, erection and efficient operation of power plants, for past eight years with consulting engineer as principal assistant; up-to-date boiler-room management and efficiency use of exhaust steam a specialty, desires position as mechanical engineer with manufacturing plant, central station or consulting engineer. Location preferred, Eastern states.

E-102 Young man, technical graduate, experienced in engineering, advertising, sales, and practical experience covering power plant operation, foundry, machine shop work and drafting room practice, desires position in advertising or sales department. Salary secondary consideration.

E-103 Mechanical engineer, 1914 graduate, desires position with manufacturing concern or consulting engineers. Will consider any offer with chance for advancement.

E-104 Technical graduate, three years experience in construction work, capable of handling men, would like to get in touch with master mechanic or chief engineer of large manufacturing concern or power company.

E-105 Member, technical graduate, wide training and experience in design of power plants and machinery, construction, maintenance and operation, purchasing engineering material, executive charge of all consulting engineering work, including building construction of all kinds, desires position as works manager or superintendent.

E-106 Member, 25 years practical experience in the design and manufacture of the highest grade of fine interchangeable work. At present employed with one of the largest concerns of its kind in the world as mechanical expert. New York or vicinity preferred.

E-107 Associate-member, age 37, married, with technical training and 17 years practical experience as machinist, draftsman, machine shop foreman and three years instructor of machine shop practice, mechanical drawing and shop mathematics, would consider position for the coming acade-

mic year in technical high school or engineering college. At present employed in a large city vocational school.

E-108 Junior member, seven years experience in economics relating to plant operation, costs, and mechanical and electrical equipment; expert on reports, plans and specifications; writes well on technical and commercial subjects.

E-109 Designing engineer, technical graduate in mechanical engineering, three years practical experience in designing work, has been employed as chief draftsman in high speed steam engine industry and in small factory building, high grade gasoline motors. Now employed in engineering department of large motor car company.

E-110 Mechanical engineer, member, age 38, with shop, designing, sales, executive and business experience desires permanent connection with manufacturer, preferably in Eastern states. Can handle engineering sales, sales office, or executive work in jobbing shops.

E-111 Member, technical graduate, broad experience in factory production work, design, construction and operation of water filtration and sewage disposal plants, consulting engineer, three years experience as district sales engineer, desires position as superintendent or sales manager.

E-112 Mechanical engineer, good personality and character, successful as organizer, executive and production engineer; thorough knowledge and experience in the principles of efficient management, has been associated with best professional exponents of scientific management; fifteen years experience as superintendent, seeks position as factory manager, superintendent or special organizer. At present engaged but desires change.

E-113 Member, A.S.M.E. and A.I.E.E., age 35, technical graduate, E.E. and M.S., 14 years practical experience in the design, construction, operation and maintenance of hydro-electric and steam electric plants, high tension transmission and distribution of electrical energy to mines and cities; estimates, investigations and reports, desires position where experience of this nature will be of advantage. Location immaterial, salary secondary.

E-114 Junior member, age 27, technical graduate, four years experience as mechanical engineer on ore and coal handling machinery, cranes, hoists, monorails and parabolic bins; also experienced in the design of water turbines and similar heavy machinery, desires position as mechanical engineer or estimator with concern who could use man of this experience.

E-115 Member, technically trained, seven years experience in mechanical engineering in foundry machine shop and brass rolling mill work; also ten years with large firm of shipbuilders as leading hull draftsman, inspector and outside man, desires position with engineering firm, or as assistant to superintendent of hull construction at a shipyard. At present employed as mechanical engineer for leading foundry.

E-116 Junior, technical graduate, nine years experience in the design and construction of steam power plants and general engineering, executive charge of the installation of turbine units for municipal lighting and railway service, desires position of similar character such as mechanical engineer for a consulting firm, engineer of construction or power engineer.

E-117 Associate-member A.S.M.E. and A.S.C.E., 13 years experience on design and construction of industrial plants, buildings and bridges, desires position of responsibility in New York or vicinity.

E-118 Student member, Cornell graduate, age 28, married, eight years experience as practical mechanic, toolmaker, master mechanic and tool inspector, desires position with opportunity for advancement, preferably in experimental work, testing, design or as instructor in physics or experimental engineering. At present employed.

E-119 Associate-member, age 30, 15 years practical experience as experimental model maker, draftsman, foreman and production engineer. Experienced as designer on metal working machines and tools. Broad practical experience as factory systematizer having served as junior for one of the foremost industrial engineers in the country, desires position as industrial engineer, superintendent or assistant manager. At present employed as efficiency engineer in plant manufacturing small interchangeable parts.

E-120 Junior, technical graduate, energetic young sales engineer, six years experience in engineering and selling special steel castings, desires position in executive or sales office with a management corporation.

E-121 Graduate M.E., young man with eight years experience as special engineer, superintendent and works manager, 150-300 men. Specialized in production, efficiency and cost methods in the foundry, machine shop and assembly department on both jobbing and repetitive manufacture. Correlative executive experience in plant construction and equipment. Present salary $3,800.

E-122 Member, technical graduate, with commercial training, speaking five languages, fully conversant with Latin and South American trade conditions, 18 years varied experience in design and construction of machinery and buildings, remodeling, maintenance and operation of industrial plants and equipment; systematizing of shops and processes along scientific management lines, testing and general plant engineering; familiar with handling men, drawing up contracts, purchasing equipment and material, appraising properties, modern methods of manufacturing and marketing products, desires to become identified with manufacturing or industrial plant in responsible administrative or executive position. At present employed.

ACCESSIONS TO THE LIBRARY

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A.I.E.E. and A.I.M.E. can be secured on request from Calvin W. Rice, Secretary of Am. Soc. M. E.

American Society of Mechanical Engineers. Report of the Committee to formulate standard specifications for the construction of steam boilers and other pressure vessels and for care of same in service known as The Boiler Code Committee. Rules for the Construction of stationary boilers and for allowable working pressures. 1914. Gift of A.S.M.E.

American Society of Mechanical Engineers. Year Book 1915. *New York, 1915.* Gift of A.S.M.E.

Automobile Club of America. Year Book 1914. *New York, 1914.* Gift of Club.

Carnegie Foundation for the Advancement of Teaching. Case Method in American law schools. Bulletin no. for 1914. Gift of Carnegie Foundation for the Advancement of Teaching.

Design of Boilers and Pressure Vessels. G. B. Haven and G. W. Sweet. *New York, J. Wiley & Sons, 1915.* Gift of publishers.

Dry Rot in Factory Timbers, 1915. *Boston, 1915.* Gift of Associated Factory Mutual Fire Insurance Companies.

Hancock's Applied Mechanics for Engineers. Revised and rewritten by N. C. Riggs. *New York, The Macmillan Co., 1915.* Gift of publishers.

This is intended as a textbook for engineering students of the junior year. Originally prepared by Professor E. L. Hancock of Purdue University, Professor Riggs has revised the text, introducing much larger use of graphic methods. W. P. C.

How to Finance a Business. 202 proved methods of raising capital. *Chicago, A. W. Shaw Co., 1912.* Gift of publishers.

A very careful analysis of methods of financing, giving bases of credit and general financial methods leading to success. W. P. C.

INSTRUCTION PAPERS ON FOUNDRY PRACTICE, Thos. D. West. Gift of author.

MOTORTANKSCHIFF "WOTAN." Gift of W. R. Haynie.

NEW YORK BOARD OF ESTIMATE AND APPORTIONMENT. Monthly Bulletin of Tests made in Laboratories conducted by the City of New York upon samples taken from Deliveries of Materials and Supplies, Dec. 1914. Gift of Board of Estimate and Apportionment.

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PRINTED ENGINEERING RESOURCES, J. M. Telleen. Reprinted from Bulletin of the Society for the Promotion of Engineering Education, vol. 5, Nov. 1914. Gift of author.

RAILWAY ECONOMICS. A collective catalogue of books in fourteen American libraries. *Chicago, University of Chicago, 1912.* Gift of Bureau of Railway Economics.

SEAL OF SAFETY. 1914, 1915. Year book of Max Ams Machine Co. Gift of Julius Brenzinger.

SPERRY GYRO-COMPASS AND NAVIGATION EQUIPMENT. Ed. 2. *New York, 1912.* Gift of Elmer A. Sperry.

SPRINGFIELD (MASS.) WATER COMMISSIONERS. Forty-first Annual Report, 1914. *Springfield, 1915.* Gift of Water Commissioners.

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CARNEGIE INSTITUTE OF TECHNOLOGY. General Catalogue 1913-14. Engineers' Club of New York. Constitution, Rules, List of Members, 1914.

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——— Goldsmiths' Company's Extension of the City and Guilds (Engineering) College, W. E. Dalby. 1914.

——— Booklet giving information as to industrial careers for young men.

OHIO UNIVERSITY. Souvenir edition of Bulletin, Summer 1914.

PRINCETON UNIVERSITY. Catalogue 1913-14.

UNIVERSITY OF CINCINNATI. Annual Catalogue 1913-14.

WESTERN SOCIETY OF ENGINEERS. Year Book 1914.

GROSSE MÄNNER DER NATURWISSENSCHAFTEN UND DER TECHNIK. Verein Deutscher Ingenieure.

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EXCHANGES

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U. S. NAVAL OBSERVATORY. American Ephemeris and Nautical Almanac, 1917. *Washington, 1915.*

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AMERICAN YEAR BOOK, 1914. *New York-Lond. 1915.*

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CAST IRON PIPE. Standard Specifications, dimensions and weights. 1914. *Burlington, N. J., 1914.* Gift of United States Cast Iron Pipe and Foundry Co.

CONSTRUCTION OF MASONRY DAMS, Chester W. Smith. *New York, 1915.*

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ABRIDGED LIST OF OFFICERS AND COMMITTEE CHAIRMEN[1]

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Research Committee, R. C. CARPENTER

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New Haven: H. B. Sargent
New York: Edward Van Winkle
Philadelphia: H. E. Ehlers
San Francisco: C. R. Weymouth
St. Louis: Edward Flad

[1] A complete list of the officers and committees of the Society will be found in the Year Book for 1915, and in the January and July 1915 issues of The Journal